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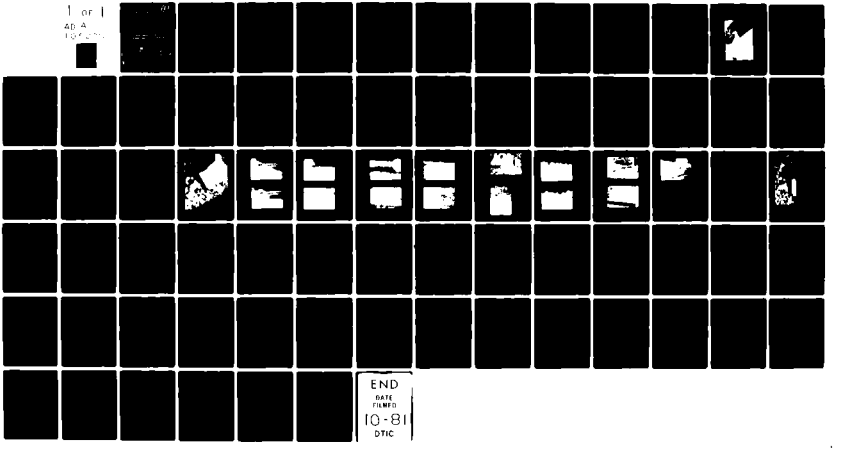

LEVEL II

MISSOURI - KANSAS CITY BASIN

BECKER LAKE DAM

FRANKLIN COUNTY, MO.

MO 31495

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

OCTOBER, 1980

UNCLASSIFIED

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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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BECKER LAKE DAM
FRANKLIN COUNTY, MISSOURI
MISSOURI INVENTORY NO. MO 31495

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY
HOSKINS-WESTERN-SONDEREGGER, INC.
CONSULTING ENGINEERS
LINCOLN, NEBRASKA

UNDER DIRECTION OF

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

OCTOBER, 1980

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

SUBJECT: Becker Lake Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Becker Lake Dam (MO 31495).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

a. The combined capacity of the spillways will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

b. Overtopping of the dam could result in failure of the dam.

c. Dam failure significantly increases the hazard to loss of life downstream.

SIGNED

28 APR 1981

SUBMITTED BY: _____ _____
Chief, Engineering Division Date

SIGNED

28 APR 1981

APPROVED BY: _____ _____
Colonel, CE, District Engineer Date

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM
ASSESSMENT SUMMARY

Name of Dam	Becker Lake Dam
State Located	Missouri
County Located	Franklin County
Stream	Tributary to Labadie Creek
Date of Inspection	October 7, 1980

Becker Lake Dam was inspected by an interdisciplinary team of engineers from Hoskins-Western-Sonderegger, Inc. The purpose of the inspection was to make an assessment of the general conditions of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers.

Becker Lake Dam has a height of thirty (30) feet and a storage capacity at the minimum top elevation of the dam of fifty-eight (58) acre-feet. In accordance with the guidelines, a small size dam has a height greater than or equal to twenty-five (25) feet but less than forty (40) feet and a storage capacity greater than or equal to fifty (50) acre-feet but less than one thousand (1,000) acre-feet. The size classification is determined by either the storage capacity or height, whichever gives the larger size category. Becker Lake Dam is classified as a small size dam.

In accordance with the guidelines and based on visual observation, the dam is classified as having a high hazard potential. Failure would threaten life and property. The estimated damage zone extends approximately one (1) mile downstream of the dam. Within the damage zone are a dwelling at about 0.4 mile, a dwelling at 0.6 mile, a trailer and 3 dwellings at 0.8 mile and Highway T at 0.9 mile.

Our inspection and evaluation indicates that the spillways do not meet the criteria set forth in the recommended guidelines for a small dam having a high hazard potential. Considering the small volume of water impounded and the downstream channel from the dam, one-half of the Probable Maximum Flood is the appropriate spillway design flood. The spillways will pass the 100-year flood (1% probability flood - a flood having a one percent chance of being exceeded in any one year) without overtopping the dam. The spillways will pass 14% of the Probable Maximum Flood without overtopping the dam. The Probable Maximum Flood (PMF) is defined as the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region.

Becker Lake Dam is in excellent condition and is very well maintained. The only deficiencies noted are inadequate spillway capacity and the lack of seepage and stability analyses as required by the guidelines for all dams having a high hazard potential.

Limited design data were available for this dam. Based on this data and on the analyses made during and subsequent to the field inspection, the following recommendations are made:

a. Alternatives.

(1) The emergency spillway size and/or the height of the dam should be increased in order to pass 50% of the probable maximum flood without overtopping the dam.

b. Operation and Maintenance Procedures.

(1) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the design and construction of dams.

(2) Regular maintenance, as now practiced by the owner, should be continued.

(3) A plan for periodic inspection of the structure should be initiated and records of inspection made a part of this project file.

Rey S. Decker
E-3703

Gordon Jamison

Garold Ulmer
E-19246

H. P. Hoskins
Harold P. Hoskins, Chairman of the Board
Hoskins-Western-Sonderegger, Inc.
E-8696

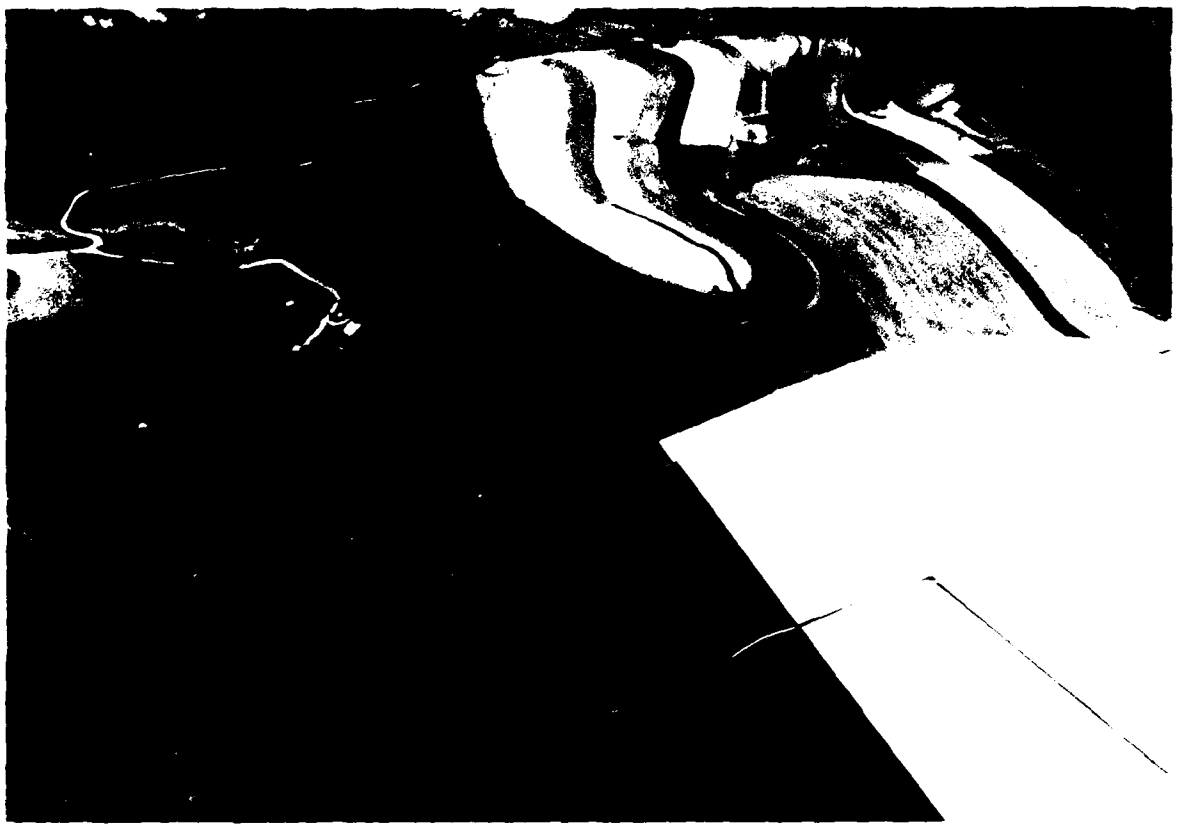


PHOTO NO. 1 - OVERVIEW

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
BECKER LAKE DAM - MO 31495
FRANKLIN COUNTY, MISSOURI

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of Becker Lake Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams", Appendix D to "Report of the Chief of Engineers on the National Program of Inspection of Dams", dated May, 1975, and published by the Department of the Army, Office of the Chief of Engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) Embankment. The embankment is an earthen structure approximately 295 feet in length and 30 feet in height. The maximum water storage at the minimum top of dam is 58± acre-feet.

(2) Principal Spillway. The principal spillway is an uncontrolled SCS type hood inlet pipe spillway.

(a) Inlet Structure. The hood inlet spillway consists of a pipe conduit with the inlet end formed by cutting the pipe at an angle. The long side of the cut is placed on top and figuratively forms a hood over the entrance. An anti-vortex wall or plate is located on the upper side of the pipe at the inlet. Photo No. 5 and Plate C-5 show the hood inlet.

(b) Conduit. The pipe spillway conduit is made of 8-inch diameter welded steel pipe. The conduit is 112.5 feet long.

(c) Stilling Basin. The pipe conduit outlets onto a concrete slab. The invert is at the top of the slab and is enclosed by a steel grating animal protection cage. Photos 10 and 11 show the outlet end of the conduit.

(3) Emergency Spillway. The emergency spillway is an uncontrolled earthen channel excavated in the right abutment. The channel is elliptical in shape with a bottom width of approximately five feet and side slopes of approximately 1V on 3.3H. There is a training dike on the left (inside) of the channel.

(4) Low-Level Outlet. There is no low-level outlet for this dam.

(5) Pertinent physical data are given in paragraph 1.3.

b. Location. The dam is located approximately one mile east of Labadie in the northeast corner of Franklin County, Missouri, as shown on Plate A-2. The dam is shown on Plate A-1 in the SE 1/4 of Section 30, T44N, R2E.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Becker Lake Dam has a height of 30 feet and a storage capacity at the minimum top of dam of 58 acre-feet. This dam is classified as a small size dam. A small size dam has a height greater than or equal to 25 feet but less than 40 feet and a storage capacity greater than or equal to 50 acre-feet but less than 1,000 acre-feet. The size classification is determined by either the storage or height, whichever gives the larger size category.

d. Hazard Classification. Guidelines for determining hazard classification of dams and impoundments are presented in the guidelines as referenced in paragraph 1.1c above.

Aerial photographs of the downstream damage zone of this dam were taken in October, 1980. These photographs were used as reference in the field observations of the damage zone which were made during the inspection. Based on the field observations and on the referenced guidelines this dam is in the High Hazard Potential Classification. The estimated damage zone extends approximately one mile downstream of the dam. Within the damage zone are a dwelling at about 0.4 mile, a dwelling at 0.6 mile, a trailer and 3 dwellings at 0.8 mile and Highway T at 0.9 mile.

e. Ownership. The dam is owned by Mr. Harold Becker, Box 115, Labadie, Missouri 63055.

f. Purpose of Dam. Flood control and recreation.

g. Design and Construction History. Becker Lake Dam was built in 1971. Minimal design data were found which consists of three sheets of plans as prepared by local SCS personnel. Mr. Becker reported that the cutoff extended 10 to 12 feet and landed in good clay.

h. Normal Operating Procedure. There are no operating facilities for this dam. The pool level is controlled by rainfall, infiltration, evaporation, and the capacity of the uncontrolled spillways.

1.3 PERTINENT DATA

a. Drainage Area. 102.6 acres (0.16 square miles).

b. Discharge at Damsite.

(1) All discharges at the damsite are through the following:

(a) An uncontrolled eight-inch welded steel pipe spillway with hood inlet.

(b) An uncontrolled earthen emergency spillway cut through the right abutment.

(2) Estimated maximum flood at damsite -- unknown.

(3) The principal spillway capacity varies from 0 c.f.s. at elevation 106.5 feet to 5.5 c.f.s. at the crest of the emergency spillway (elevation 110.0 feet) to 5.7 c.f.s. at the minimum top of dam (elevation 111.6 feet).

(4) The emergency spillway capacity varies from 0 c.f.s. at its crest (elevation 110.0 feet) to 49 c.f.s. at the minimum top of dam (elevation 111.6 feet).

(5) Total spillway capacity at the minimum top of dam is 55 c.f.s. ±.

c. Elevations (feet, SCS plans).

(1) Observed pool - 105.2

(2) Normal pool - 106.5

(3) Spillway crests

Principal - 106.5

Emergency - 110.0

(4) Maximum experienced pool - unknown

(5) Top of dam (minimum) - 111.6

(6) Streambed - 82±

(7) Maximum tailwater - unknown

d. Reservoir. Length (feet) of pool.

(1) At principal spillway crest - 900±

(2) At emergency spillway crest - 1050±

(3) At top of dam (minimum) - 1100±

e. Storage (acre-feet).

(1) Observed pool - 28±

(2) Normal pool - 32±

(3) Spillway crests

Principal - 32±

Emergency - 49±

(4) Maximum experienced pool - unknown

(5) Top of dam (minimum) - 58±

f. Reservoir Surface (acres).

(1) Observed pool - 3.7±

(2) Normal pool - 4.1±

(3) Spillway crests

Principal - 4.1±

Emergency - 5.3±

(4) Maximum experienced pool - unknown

(5) Top of dam (minimum) - 5.9±

g. Dam.

(1) Type - earthfill

(2) Length - 295 ft. ±

(3) Height - 30 ft. ±

(4) Top width - 12 ft. ±

(5) Side slopes

(a) Downstream - 1V to 2.4±H (measured)

(b) Upstream - 1V to 3.4±H (measured)

(6) Zoning - none

(7) Impervious core - none

(8) Cutoff - 10 to 12 feet in depth, 1:1 side slopes

(9) Grout curtain - none

(10) Wave protection - vegetation

(11) Drains - none

h. Diversion Channel and Regulating Tunnel. None

i. Spillways.

(1) Principal

(a) Type - The principal spillway is an uncontrolled 8-inch diameter welded steel pipe conduit equipped with a hood inlet.

(b) Crest (invert) Elevation - 106.5 ft.

Outlet - 82.0 ft.

(c) Length - 112.5 ft.

(2) Emergency

(a) Type - The emergency spillway is an uncontrolled vegetated earth channel cut through the right abutment. The channel is elliptical in shape with a bottom width of approximately 5 feet and side slopes of approximately 1V on 3.3H.

(b) Control Section - A level section 15 ft. long near the centerline of the dam.

(c) Crest Elevation - 110.0±

(d) Upstream Channel - Vegetated, open and clear. Approach grade - 4.4%.

(e) Downstream Channel - Vegetated, open and clear. 3.5% grade. Discharges into old channel approximately 300 feet downstream.

j. Regulating Outlets. None

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Design data consisting of three sheets of drawings were furnished by the owner. Information on the sheets consists of a sketch plan of the dam and emergency spillway, a cross section through the dam showing a hood inlet type principal spillway, and details for construction of the hood inlet and anti-seep collars. The drawings were done by Soil Conservation Service and copies are included in this report in Appendix C.

2.2 CONSTRUCTION

No construction data were available. Mr. Becker reported that the dam was constructed in 1971 and that the core trench had been excavated to depths of 10 to 12 feet into clay.

2.3 OPERATION

No data were available on spillway operation. Mr. Becker reported that flows have never occurred in the emergency spillway.

2.4 EVALUATION

a. Availability. The data included in Appendix C were readily available from the owner.

b. Adequacy. The Soil Conservation Service plans furnished by the owner and the field surveys and visual observations presented herein are considered adequate to support the conclusions of this report. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity. The data furnished are considered to be valid.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. A visual inspection of the Becker Lake Dam was made on October 7, 1980. Engineers from Hoskins-Western-Sonderegger, Inc., Lincoln, Nebraska, making the inspection were:

Rey S. Decker - Geotechnical
Garold G. Ulmer - Hydraulics and Hydrology
Gordon Jamison - Hydraulics and Hydrology

The owner, Mr. Harold Becker, and Mr. Leonard A. Knoernschild, District Conservationist, Soil Conservation Service, Franklin County, were present during the inspection.

b. Dam.

(1) Geology and Soils (abutment and embankment). The embankment is situated on the Menfro soil in the loess mantled uplands. Bedrock, which is not exposed at the site, occurs at greater than 10 feet depth. It is the Joachim Formation; a yellowish brown, argillaceous dolomite with interbedded limestones and shales of the Ordovician System. The significant structural features within 10 miles of the site are the Eureka-House Springs Anticline and the Moselle Fault.

Groundwater movement at the site is controlled by the underlying loess composed of silty clays and clayey silts. Hydraulic conductivities range from 1 to 0.1 ft/day. The Menfro soil developed on the loess can be described as well drained. The loess mantling the bedrock surface ranges from approximately 10 to 20 feet thick. The bedrock is locally "tight", not yielding to municipal wells. Secondary porosity is limited with a low potential for sinkhole collapse.

The epicenter for a May, 1945 earthquake was located on the Moselle Fault (Frank, 1945). The focus was calculated at 44 kilometers suggesting deep-seated movement. This fault occurs approximately 8 miles to the southwest of the site.

The Eureka-House Springs Anticline crests to the east in Section 36, T44N, R3E.

The site occurs in Seismic Zone 2 which is indicative of a moderate probability for damage. Earthquakes having a Modified Mercalli intensity of IV or over occurring within a radial distance of 50 miles are as follows:

1902 VI
1911 IV
1930 IV
1933 IV
1945 IV

The soil in the abutments and embankment is a silty clay (CL) material.

(2) Upstream Slope. The upstream slope is very well vegetated with adapted grasses. No brush or trees were observed. No erosion, cracks, slumps, slides or deformations were observed on the slope. The vegetative growth has provided good protection against erosion. The slope is somewhat flatter than the planned 1V on 3H. The upstream slope is shown in Photo No. 3.

(3) Crest. The crest is well vegetated with adapted grasses. No significant erosion, cracks or slumps were observed. The center section (Stations 1+50 to 2+50) is about 0.5 feet lower than the ends. The crest is shown in Photo No. 2.

(4) Downstream Slope. The downstream slope is very well vegetated with adapted grasses. No cracks, slumps, slides or other deformations were noted. No erosion nor rodent activity was evident. No evidence of seepage was observed in the abutment troughs, on the slope or along the toe of the dam; however, seepage water was standing in the scour hole downstream from the outlet of the pipe spillway. Test borings taken up the slope from the toe of the dam indicated dry to moist CL material to a depth of 2 to 3 feet. Photo No. 4 shows the downstream slope.

c. Appurtenant Structures.

(1) Principal Spillway.

(a) Inlet Structure. The hood inlet was clear and unobstructed and is constructed as shown on Plate C-5. The water level in the lake was 1.3 feet below the invert of the inlet at the time of inspection. Photo No. 5 shows the inlet.

(b) Conduit. The 8-inch welded steel pipe conduit appeared to be in excellent condition. Plate C-4 shows three anti-seep collars. Mr. Becker reported that the spillway had not operated during the summer.

(c) Stilling Basin. The spillway conduit outlets onto a concrete slab that is enclosed by a steel grating cage which serves as an animal guard and to some extent as an energy dissipator. A scour hole located immediately downstream from the concrete slab contained seepage water. There was no flow from the

stilling basin nor was there any sign of boils. Photos 10 and 11 show the outlet end of the conduit and the scour hole.

(2) Emergency Spillway. The emergency spillway is in excellent condition. A training dike on the left side of the channel diverts spillway flows away from the right abutment trough of the dam. The spillway is covered with an excellent growth of adapted grasses which had recently been mowed. Mr. Becker stated that the spillway had never operated. Photos 8, 9 and 13 show the emergency spillway. Photo No. 1 - Overview distinctly shows the spillway as it appears from overhead.

(3) Low-Level Outlet. There is no low-level outlet.

d. Reservoir Area. The area surrounding the reservoir is well vegetated with grasses. No significant erosion or siltation was noted around the reservoir. Photo No. 6 shows a portion of the reservoir.

e. Downstream Channel. The downstream channel is overgrown with trees and brush. Photo No. 7 shows the channel downstream from the dam. Photo No. 15 shows the channel at the outlet confluence with the larger drainageway from the southeast.

3.2 EVALUATION

This structure appears to be in excellent structural condition and is very well maintained.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no controlled outlet works for this dam. The pool level is controlled by rainfall, infiltration, evaporation, and the capacity of the uncontrolled spillways.

4.2 MAINTENANCE OF DAM

This structure is very well maintained. Mr. Becker mows as needed and apparently removes all trees and brush at frequent intervals. He also traps out muskrat and/or beaver whenever they appear.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facilities exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system in effect for this dam.

4.5 EVALUATION

The excellent condition of this dam is due to the frequent maintenance work performed by Mr. Becker.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. Drawings for this dam, which were done by the Soil Conservation Service, were furnished by the owner and are included in Appendix C of this report.

b. Experience Data. The drainage area, reservoir surface area, and elevation-storage data were developed from the USGS Labadie, Missouri 7-1/2 minute topographic quadrangle map. The hydraulic computations for the spillway and dam overtopping discharge ratings were based on data collected in the field at the time of the field inspection. Hydraulic/hydrologic computations are included as Appendix D of this report.

c. Visual Observations.

(1) The dam and its spillways appear to be in excellent structural condition and well maintained.

d. Overtopping Potential. The spillways are too small to pass 50% of the probable maximum flood without overtopping the dam. The spillways will pass 14% of the probable maximum flood and will also pass the 1% probability flood without overtopping. Overtopping is dangerous because the flow of water over the crest could erode the face of the dam and, if continued long enough, could breach the dam with a sudden release of all of the impounded water onto the downstream floodplain.

The results of the routings through the dam are tabulated in regards to the following conditions:

Frequency	Inflow Discharge c.f.s.	Outflow Discharge c.f.s.	Maximum Pool Elevation	*Maximum Depth Over Dam Feet	Duration Over Top Hours
1%	440	35	111.2	-	-
1/2 PMF	945	875	112.8	1.2	5+
PMF	1890	1860	113.5	1.9	7+
0.14 PMF	275	55	111.6	-	-

*Minimum top of dam elevation - 111.6 ft.

According to the recommended guidelines from the Department of the Army, Office of the Chief of Engineers, this dam is classified as having a high hazard potential and a small size. Therefore, the 1/2 PMF to PMF is the test for the adequacy of the dam and its spillway.

The estimated damage zone is described in paragraph 1.2 d in this report.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observation. Based on visual observation this dam appears to be in excellent structural condition and is very well maintained. There is no evidence of cracks, slides, slumps, erosion, animal burrows or seepage on the downstream slope. The nature of the embankment materials combined with flatter than normal slopes should provide adequate safety against shear failure for a dam of this height.

b. Design and Construction Data. Very sketchy design data prepared by the Soil Conservation Service was loaned to the inspection team by the owner. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Operating Records. There are no controlled operating facilities for this dam.

d. Post-Construction Changes. No changes have been made on this dam since it was constructed.

e. Seismic Stability. This dam is located in Seismic Zone 2. An earthquake of the magnitude predicted in this area could be expected to cause moderate structural damage to this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. Based on visual inspection this dam appears to be in excellent structural condition and is very well maintained. Approximate analyses presented in this report indicate that the spillways will pass the 1 percent probability flood without overtopping the dam but 50 percent of the probable maximum flood will overtop the dam by 1.2 feet for about 5 hours. The effects of overtopping on the stability of the dam are not known. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available which is considered a deficiency.

b. Adequacy of Information. The conclusions in this report are based upon minimal engineering data, performance history, and visual observations. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available which is considered a deficiency.

c. Urgency. There does not appear to be an immediate urgency to accomplish the remedial measures recommended in paragraph 7.2.b. The item recommended in paragraph 7.2.a should be pursued on a high priority basis.

d. Necessity for Further Investigations. Prior to any action being taken on the remedial measure recommended in item 7.2.a, the owner should have a breach routing of the dam performed to determine the downstream effects in case of failure of the dam.

e. Seismic Stability. This dam is located in Seismic Zone 2. An earthquake of this magnitude is expected to produce moderate damage to this dam. It is recommended that the prescribed seismic loading for Seismic Zone 2 be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a registered professional engineer experienced in the design and construction of earth dams.

a. Alternatives.

(1) The emergency spillway size and/or the height of the dam should be increased in order to pass 50% of the probable maximum flood without overtopping the dam.

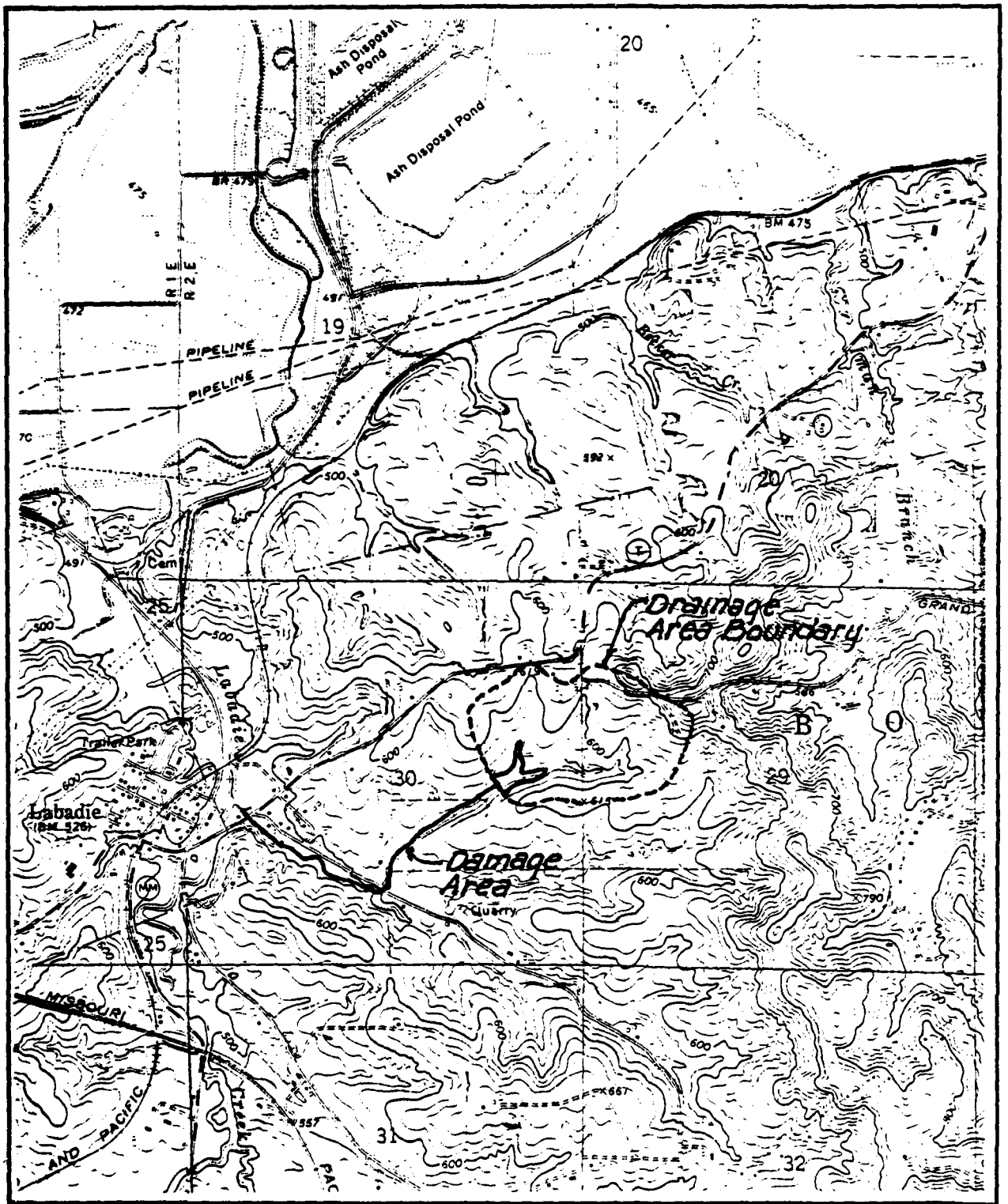
b. Operation and Maintenance Procedures.

(1) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the design and construction of dams.

(2) Regular maintenance, as now practiced by the owner, should be continued.

(3) A plan for periodic inspection of the structure should be initiated and records of inspection made a part of this project file.

APPENDIX A
MAPS



Scale in feet

2000 1000 0 2000 4000

Contour Interval – 20'

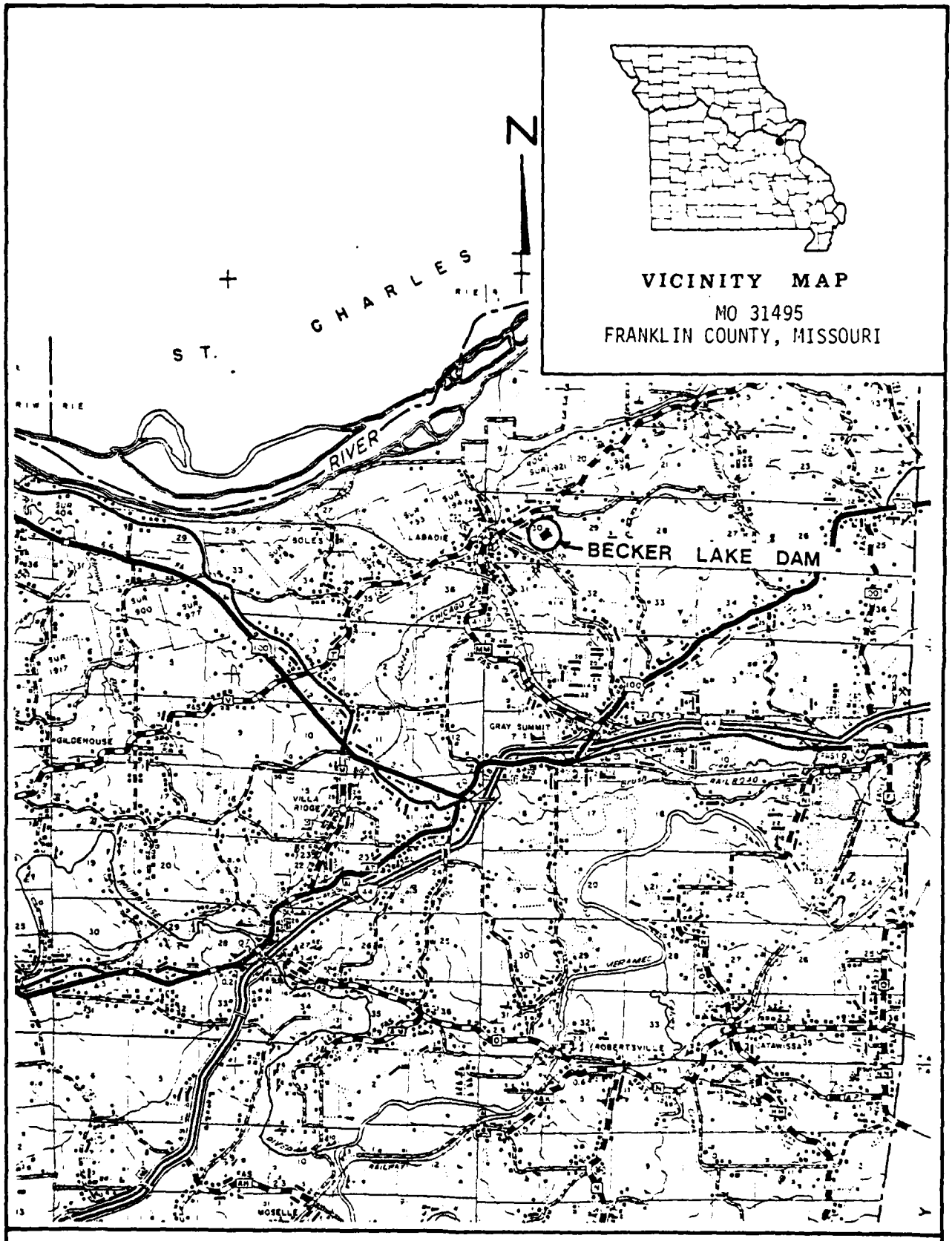
N

VICINITY TOPOGRAPHY

BECKER LAKE DAM

FRANKLIN COUNTY, MO.

MO 31495 PLATE A-1


N
ST. CHARLES
RIVER
BECKER LAKE DAM
VICINITY MAP
MO 31495
FRANKLIN COUNTY, MISSOURI
Scale in miles
0 1 2 3 4 5
LOCATION MAP
PLATE A-2

APPENDIX B
PHOTOGRAPHS

BECKER LAKE DAM

FRANKLIN COUNTY, MO.

MO 31495

PHOTO INDEX

PLATE B-1

PHOTO NO. 2 - CREST FROM LEFT END

PHOTO NO. 3 - UPSTREAM SLOPE FROM LEFT END

PHOTO NO. 4 - DOWNSTREAM SLOPE FROM LEFT END

PHOTO NO. 5 - PRINCIPAL SPILLWAY INLET

PHOTO NO. 6 - VIEW UPSTREAM ACPOSS LAKE, PRINCIPAL SPILLWAY INLET IN FOREGROUND

PHOTO NO. 7 - VIEW DOWNSTREAM. OUTLET END OF PRINCIPAL SPILLWAY IN LOWER CENTER OF PHOTO

PHOTO NO. 8 - VIEW OF ENTRANCE TO EMERGENCY SPILLWAY

PHOTO NO. 9 - VIEW DOWNSTREAM IN EMERGENCY SPILLWAY

PHOTO NO. 10 - OUTLET END OF PRINCIPAL SPILLWAY

PHOTO NO. 11 - VIEW UPSTREAM SHOWING OUTLET END OF PRINCIPAL SPILLWAY

FORM 8

PHOTO NO. 12 - OVERVIEW TAKEN FROM UPSTREAM ON RIGHT SIDE

FORM 9

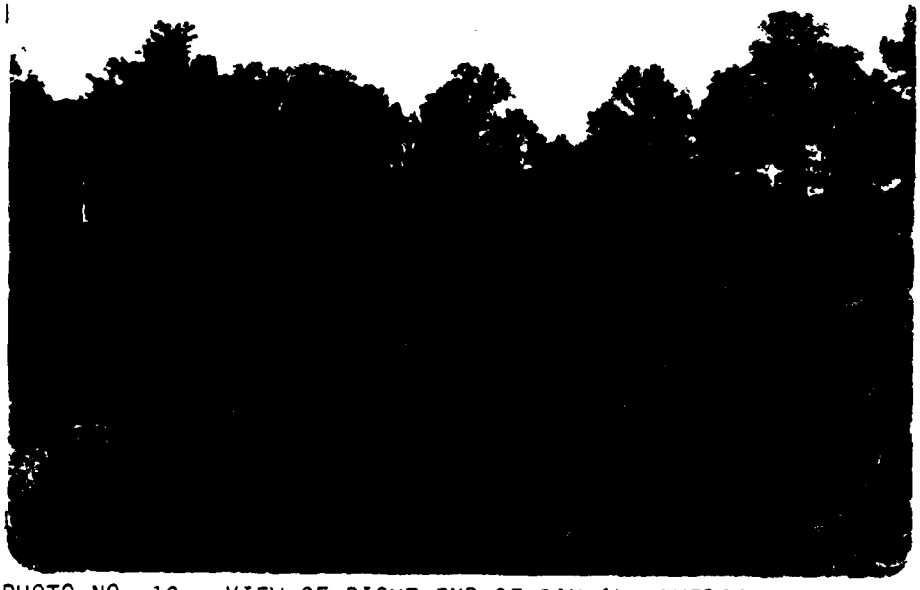


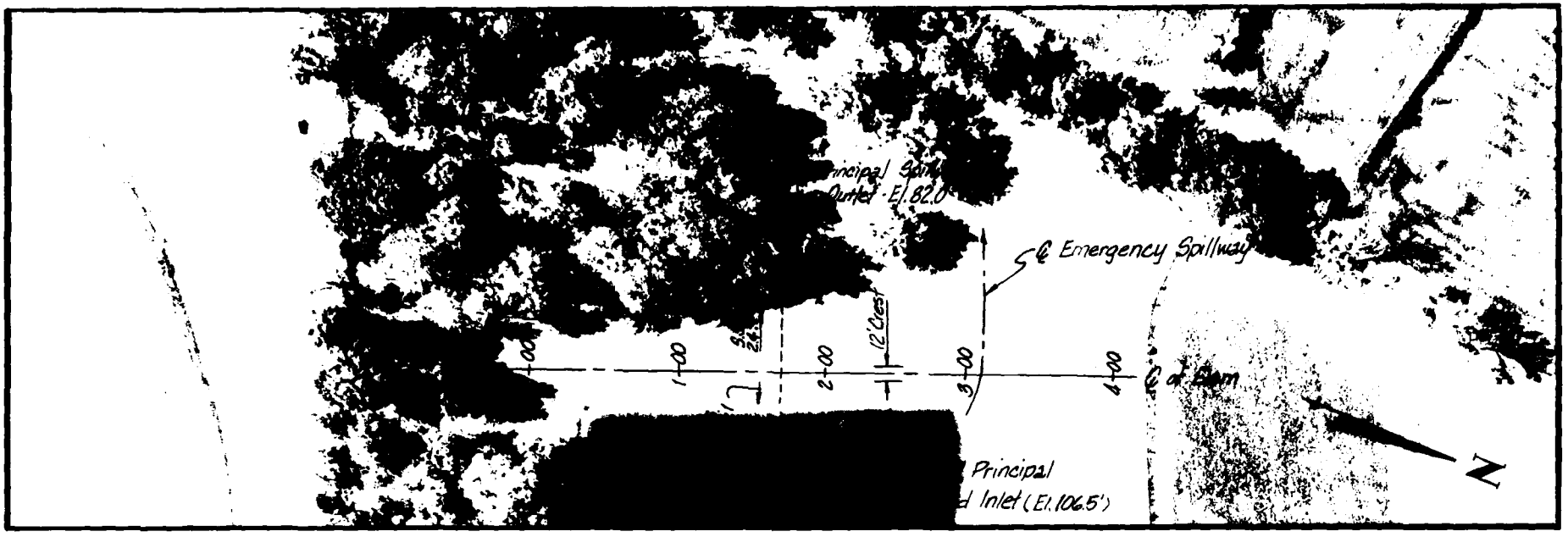
PHOTO NO. 13 - VIEW OF RIGHT END OF DAM AND EMERGENCY SPILLWAY

PHOTO NO. 14 - OVERVIEW TAKEN FROM EAST END OF LAKE

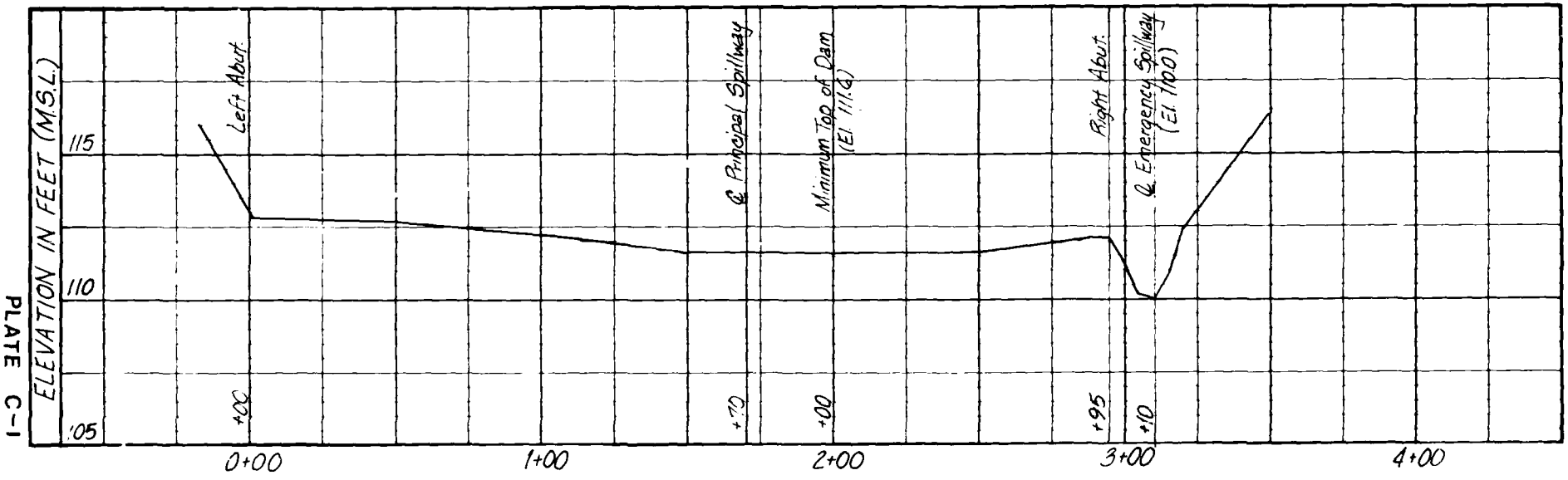
PHOTO NO. 15 - ABOUT 1/2 MILE BELOW DAM LOOKING DOWNSTREAM IN CHANNEL FROM DAM AT CONFLUENCE WITH LARGER CREEK COMING IN FROM THE LEFT

PHOTO NO. 16 - TRAILER HOUSES ON BANK OF THE LARGER CREEK JUST BELOW THE CONFLUENCE

APPENDIX C
PROJECT PLATES

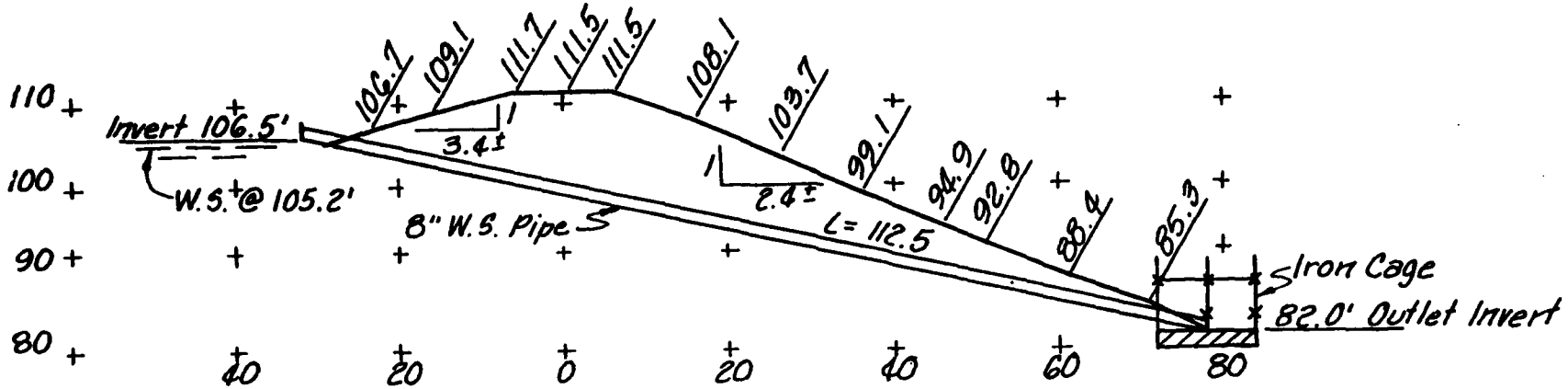


PLAN OF DAM
Scale: 1"=100'



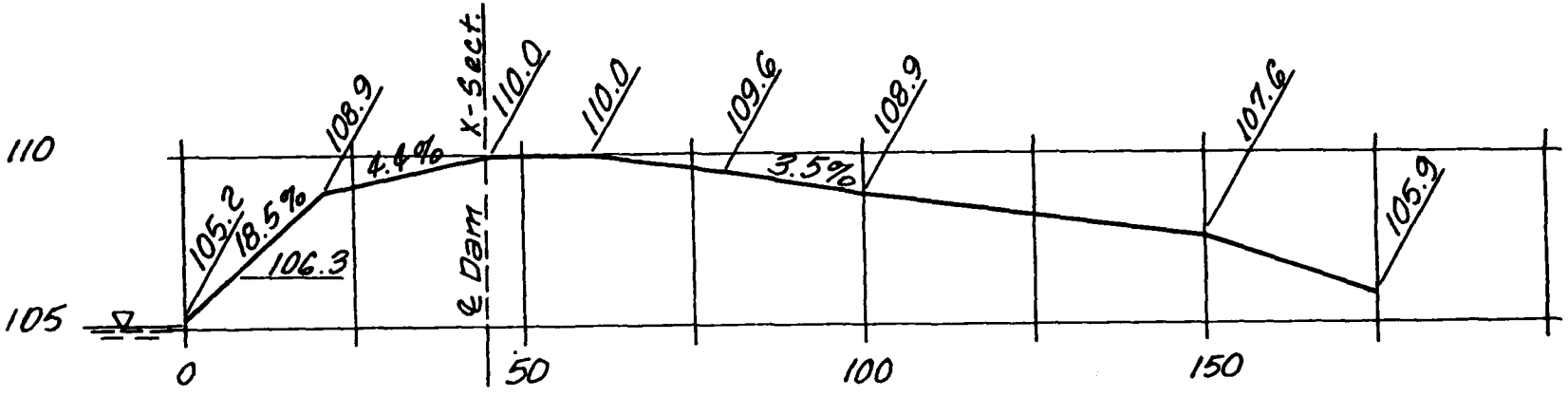
CENTERLINE PROFILE OF DAM
Scale As Shown

PLATE C-1



MAXIMUM CROSS-SECTION OF DAM AT STA. 1+70

Scale: 1"=20'



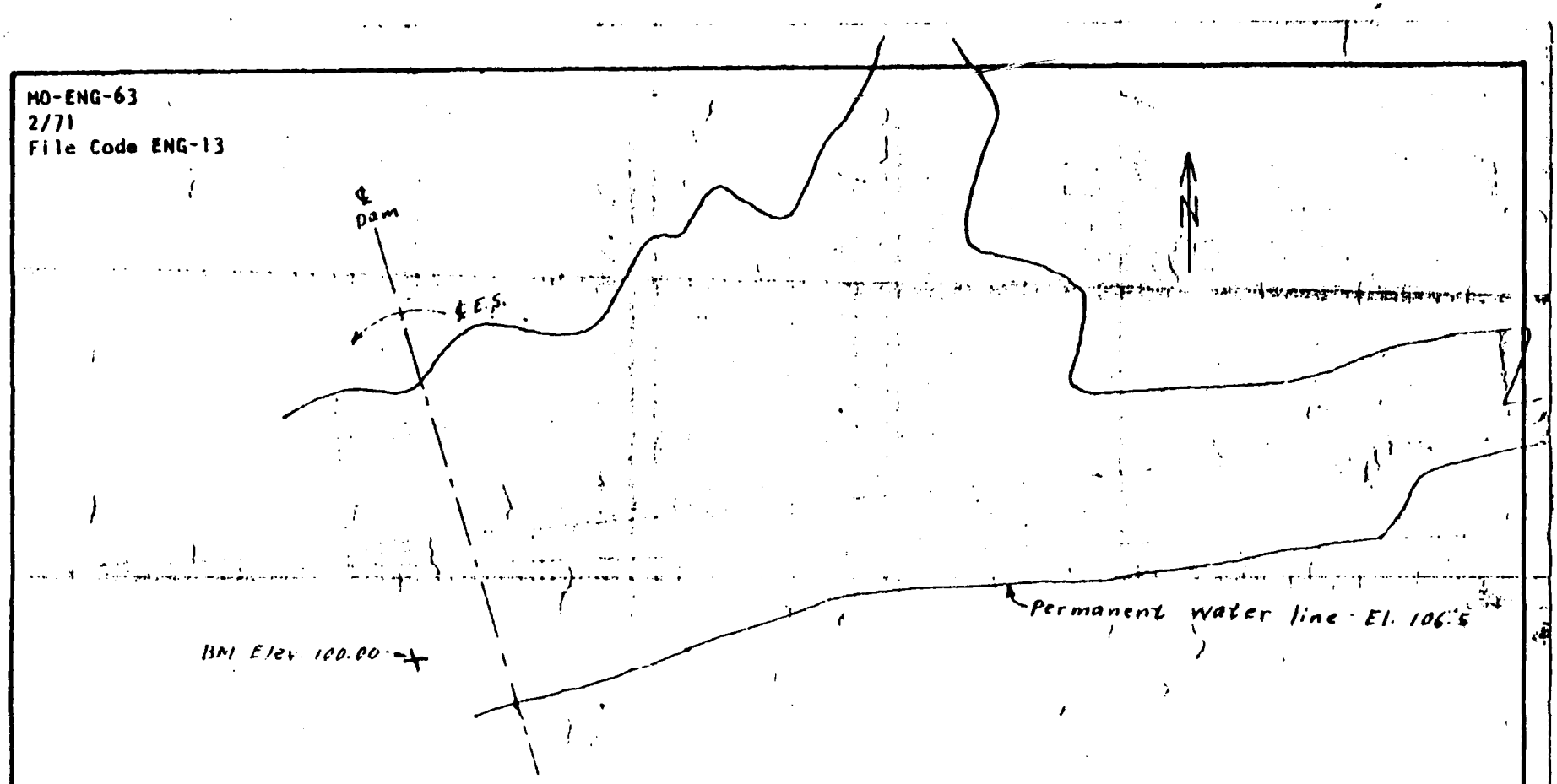
PROFILE ALONG CENTERLINE OF EMERGENCY SPILLWAY

Scale: 1"=25'H

1"=5'V

PLATE C-2

MO-ENG-63
2/71
File Code ENG-13



PLAN VIEW - SKETCH OF DAM AND SPILLWAYS

Not to scale

Approximate surface area 3.7 acres.
Permanent pool elevation 106.5.
TBM No._____ Elev._____ Description_____

TBM No._____ Elev._____ Description_____

Sheet___ of___

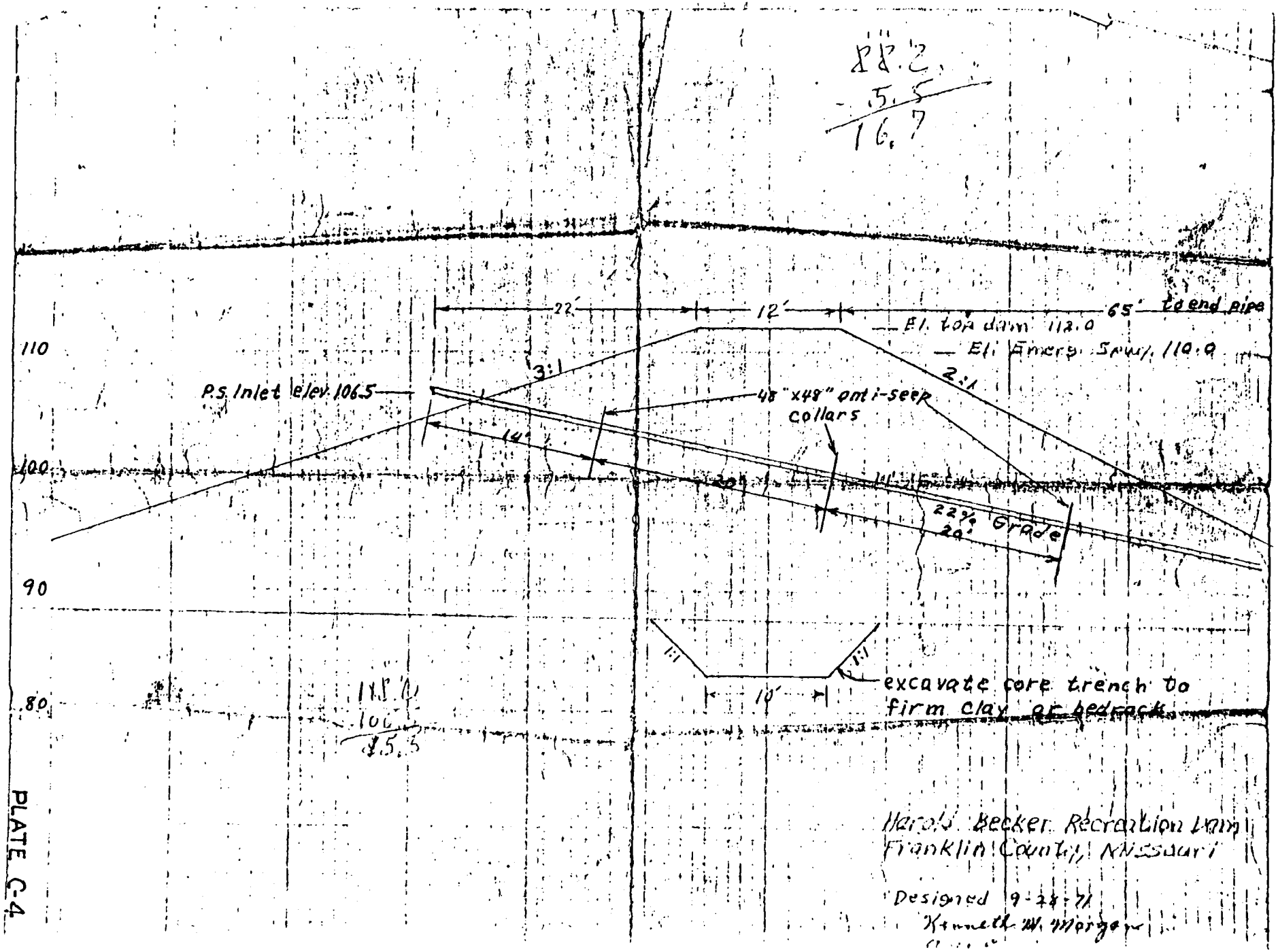
UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Recreation Dam

Landowner Harold Becker
Franklin County, Missouri
Designed by KWM Date 9-28-71
Checked by Date
Approved by Kenneth M. Morgan Date 9-28-71

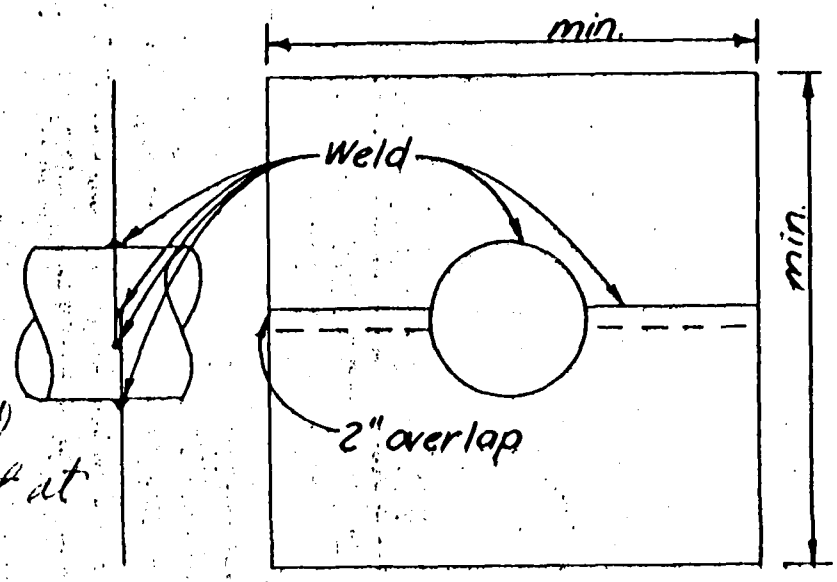
S.I.-28.922

PLATE C-3


22'
12'
65' to end pipe
El. top dam 112.0
El. Emerg. Spwy. 110.9
110
3:1
2:1
P.S. Inlet elev. 106.5
48"x48" anti-seep collars
14'
100
20'
22½% Grade
20'
90
1:1
1:1
excavate core trench to firm clay or bedrock
10'
80
PLATE C-4
Harold Becker Recreation Lake
Franklin County, Missouri
Designed 9-24-71
Kenneth W. Morgan

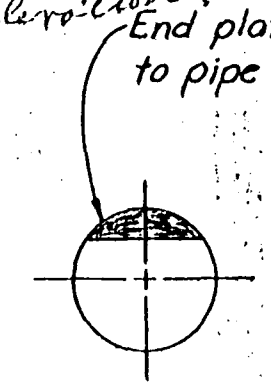
Notes:
1. All welds shall be watertight.
2. All pipe and steel plates shall have minimum thickness of ____

Harold - Use 16" length of 8" pipe to fabricate canopy and then butt weld to pipe in fill. This will put inlet at correct elevation.

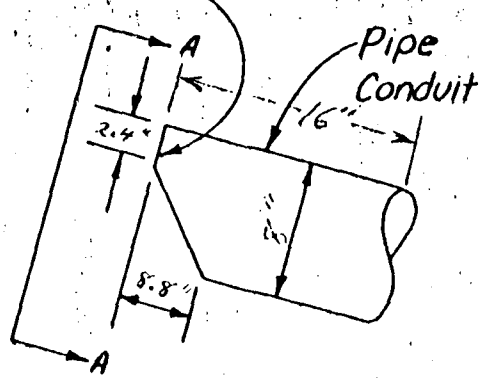


ANTI-SEEP COLLAR

Not to Scale



SECTION A-A



SECTION ALONG ℄ OF INLET

INLET SECTION

16" Long

COOPERATOR Harold Becker SEC. ____ T. ____ R. ____
COOPERATING WITH ____
COUNTY ____ STATE ____
SURVEYED ____ DATE ____

DETAILS FOR WELDED STEEL CANOPY INLET SPILLWAY

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed ____ Date ____
Drawn ____
Traced ____
Checked ____
Approved by ____
Title ____
Title ____
Sheet No ____ of ____
Drawing No 5,L-28,454

PLATE C-5

APPENDIX D
HYDRAULIC AND HYDROLOGIC DATA

HYDROLOGIC COMPUTATIONS

1. The SCS dimensionless unit hydrograph and the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Corps of Engineers, Davis, California, were used to develop the inflow hydrographs (see this Appendix).

   a. Twenty-four hour, one percent probabilistic rainfall for the dam location was taken from the data for the rainfall station at Sullivan, MO. as supplied by the St. Louis District, Corps of Engineers per their letter dated 6 March 1979. The twenty-four hour probable maximum precipitation was taken from the curves of Hydrometeorological Report No. 33 and current Corps of Engineers and St. Louis policy and guidance for hydraulics and hydrology.

   b. Drainage area = 0.16 square miles (102.6 acres).

   c. Time of concentration of runoff = 10 minutes (computed from the "Kirpich" formula and verified using the California Hwy. and P.W. formula).

   d. The antecedent storm conditions for the probable maximum precipitation were heavy rainfall and low temperatures which occurred on the previous 5 days (SCS AMC III). The antecedent storm conditions for the one percent probabilistic precipitation were an average of the conditions which have preceded the occurrence of the maximum annual flood on numerous watersheds (SCS AMC II). The initial pool elevation was assumed at the invert of the principal spillway.

   e. The total twenty-four hour storm duration losses for the one percent probabilistic storm were 2.88 inches. The total losses for the PMF storm were 1.58 inches. These data are based on SCS runoff curve No. 75 and No. 88 for antecedent moisture conditions SCS AMC II and AMC III respectively. The watershed is composed of primarily SCS soil groups B and C (Menfro-Winfield soils). The watershed is primarily in grass and trees.

   f. Average soil loss rates = 0.05 inch per hour approximately (for PMF storm, AMC III).

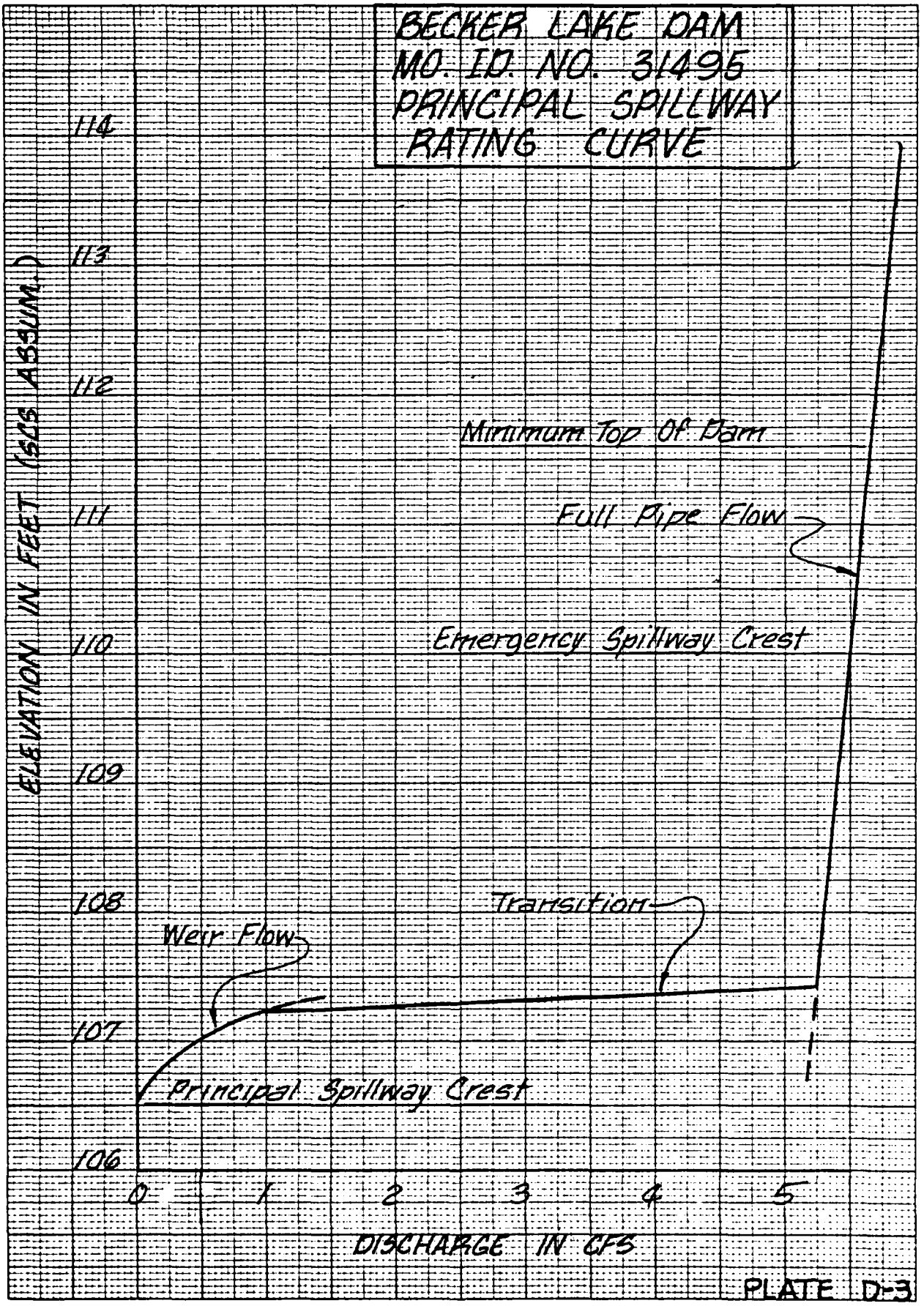
2. The combined discharge rating consisted of three components: the flow through the principal spillway, the flow through the emergency spillway, and the flow going over the top of the dam.

   a. The principal spillway rating was developed by using the weir and full conduit flow equations and coefficients as found in SCS TR No. 3 "Hood Inlets for Culvert Spillways".

b. The emergency spillway rating curve was developed using the Corps of Engineers, Water Surface Profile HEC-2 computer program. The critical depth method was used assuming critical depth of the spillway dropoff.

c. The flows over the dam were determined by using the dam overtopping analyses (irregular top of dam) within the HEC-1 (Dam Safety Version) program.

3. Floods were routed through the reservoir using the HEC-1 (Dam Safety Version) program to determine the capabilities of the spillway and dam embankment crest. The input, output and plotted hydrographs are attached to this Appendix.



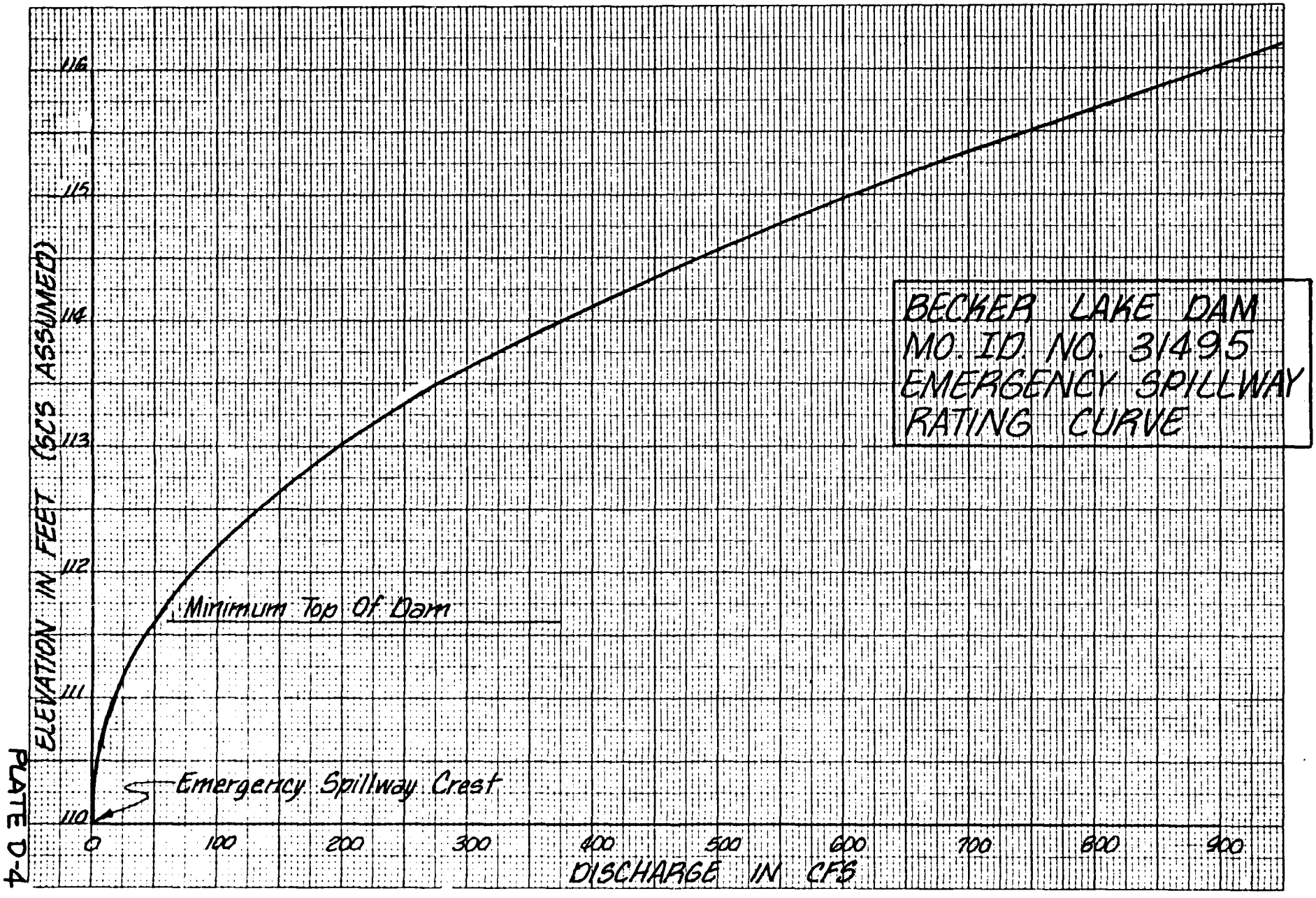


PLATE D-4

BECKER LAKE DAM
MO. ID NO. 31495
ELEVATION - AREA CURVE

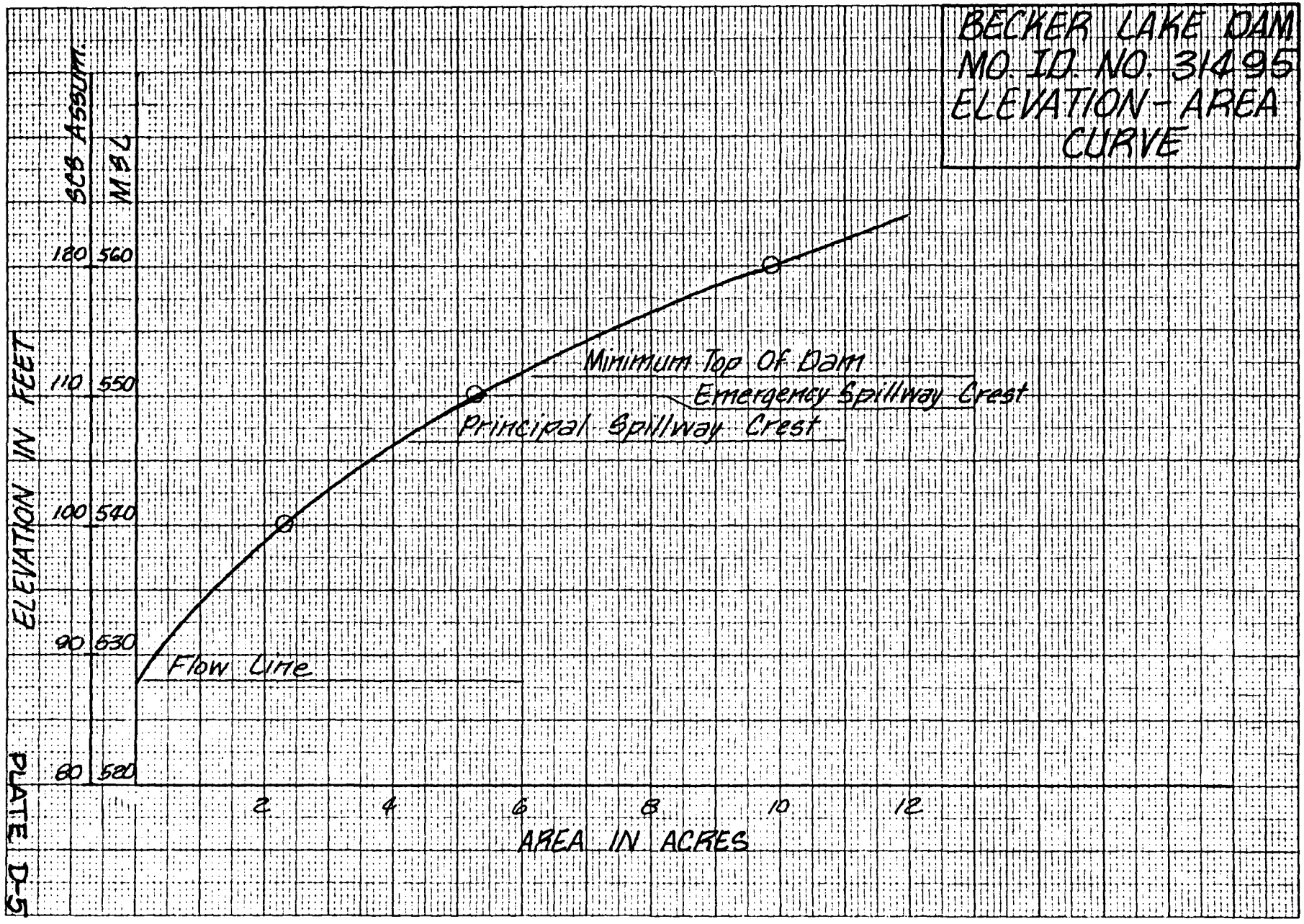
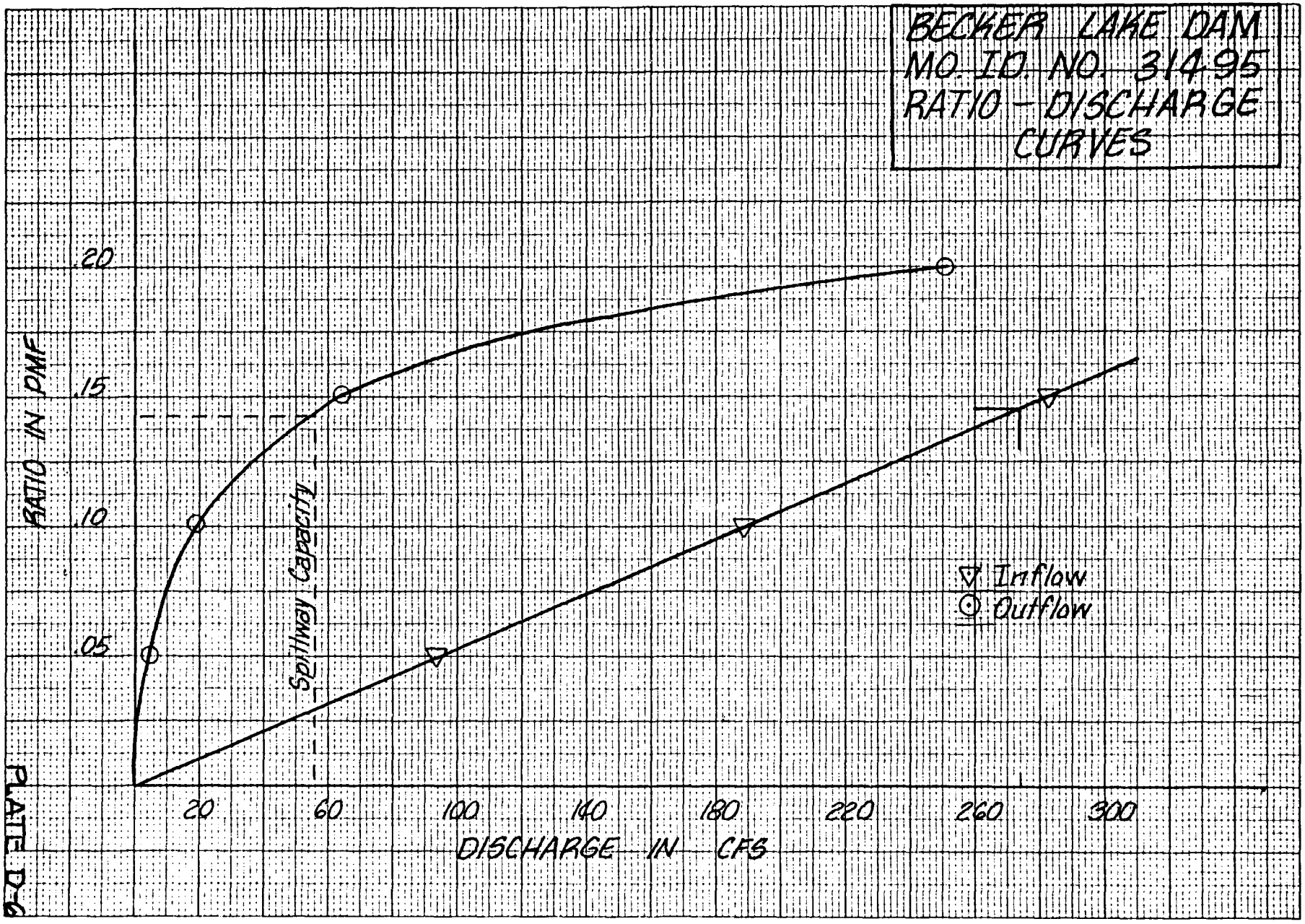


PLATE D-5



```
A1                        BECKER LAKE DAM / MO ID NO 31495
A2       SAFETY ANALYSIS OF DAM OVERTOPPING USING ASSIGNED FLOOD FREQUENCIES
A3                 H & H ANALYSIS BY ROUTING PMF RATIOS THRU THE RESERVOIR
B 000288000000000000005                                  000000000000000000000003
B1000005
J 000001000000800000001
J1000.0500000.1000000.1500000.2000000.2500000.3500000.50000001.0
K 00000000000001                         000000000000000000000001
K1       CALCULATION OF INFLO HYDRO TO BECKER LAKE
M 000001000000200000.16          00000.16000001.0                              00000001
P 000000000025.5000001020000012100000130
T                                                                -1.0    -88.0
W2       00000.17
X 000000     -.0100000001
K 00000100000002                         000000020000000000000001
K1       ROUTED FLOWS THRU BECKER LAKE DAM
Y                              000000100000001                                 -106.5        -1
Y1000001
Y40106.5000106.8000107.0000107.2000107.3000107.5000109.0000110.0000110.5000111.0
Y40111.5000112.0000112.5000113.0000113.5000114.0000114.5000115.0000116.0
Y50000000000000.2000000.6000000.9000003.0000005.2000005.4000005.5000010.5000022.6
Y500004700000088000001410000020400000284000003790000049100000616000009O6
$A0000.0000000.3000001.2000002.3000003.6000005.3000007.4000009.9
$E0088.0000090.0000095.0000100.0000105.0000110.0000115.0000120.0
$$0106.5
$D0111.6000002.8000001.500000295
$L000100000001750000018000000195000002450000029500000307
SV0111,6000112,1000112,1000112,3000112,7000112,8000115,0
K 000099
A
A
A
A
A
```

PLATE D-7

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

RUN  DATE= 80/10/21.
     TIME= 14.42.28.

                    BECKER LAKE DAM / MO ID NO 31495
          SAFETY ANALYSIS OF DAM OVERTOPPING USING ASSIGNED FLOOD FREQUENCIES
                  H & H ANALYSIS BY ROUTING PMF RATIOS THRU THE RESERVOIR

                                JOB SPECIFICATION
      NO     NHR    NMIN    IDAY     IHR    IMIN   METRC    IPLT    IPRT   NSTAN
     288       0       5       0       0       0       0       0       3       0
                                JOPER     NWT   LROPT   TRACE
                                    5       0       0       0

                    MULTI-PLAN ANALYSES TO BE PERFORMED
                          NPLAN= 1 NRTIO= 8 LRTIO= 1
          RTIOS=    .05    .10    .15    .20    .25    .35    .50   1.00

**********      **********      **********      **********      **********

                          SUB-AREA RUNOFF COMPUTATION

                  CALCULATION OF INFLO HYDRO TO BECKER LAKE

                ISTAQ   ICOMP   IECON   ITAPE   JPLT    JPRT   INAME  ISTAGE  IAUTO
               000001       0       0       0      0       0       1       0      0

                                HYDROGRAPH DATA
          IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO  ISNOW  ISAME  LOCAL
              1       2     .16    0.00     .16    1.00   0.000      0      1      0

                                PRECIP DATA
            SPFE     PMS      R6     R12     R24     R48     R72     R96
            0.00   25.50  102.00  121.00  130.00    0.00    0.00    0.00

                                LOSS DATA
     LROP    STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
             0.00    0.00    1.00    0.00    0.00    1.00   -1.00  -88.00    0.00    0.00

          CURVE NO =  -88.00  WETNESS =   -1.00  EFFECT CN =   88.00

                              UNIT HYDROGRAPH DATA
                        TC=  0.00   LAG=   .17

                              RECESSION DATA
                        STRTQ=    0.00   QRCSN=   -.01   RTIOR= 1.00

     UNIT HYDROGRAPH 12 END OF PERIOD ORDINATES, TC=    0.00 HOURS, LAG=   .17  VOL= 1.00
  111.     336.     345.     216.     108.      58.      31.      16.       9.       4.
    3.       1.

  0                           END-OF-PERIOD FLOW
```

PLATE D-8

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	0.	1.01	12.05	145	.22	.21	.01	96.
1.01	.10	2	.01	0.00	.01	0.	1.01	12.10	146	.22	.21	.01	144.
1.01	.15	3	.01	0.00	.01	0.	1.01	12.15	147	.22	.21	.01	194.
1.01	.20	4	.01	0.00	.01	0.	1.01	12.20	148	.22	.21	.01	226.
1.01	.25	5	.01	0.00	.01	0.	1.01	12.25	149	.22	.21	.01	242.
1.01	.30	6	.01	0.00	.01	0.	1.01	12.30	150	.22	.21	.01	251.
1.01	.35	7	.01	0.00	.01	0.	1.01	12.35	151	.22	.21	.01	255.
1.01	.40	8	.01	0.00	.01	0.	1.01	12.40	152	.22	.21	.01	258.
1.01	.45	9	.01	0.00	.01	0.	1.01	12.45	153	.22	.21	.01	260.
1.01	.50	10	.01	0.00	.01	0.	1.01	12.50	154	.22	.21	.01	261.
1.01	.55	11	.01	0.00	.01	0.	1.01	12.55	155	.22	.21	.00	262.
1.01	1.00	12	.01	0.00	.01	0.	1.01	13.00	156	.22	.21	.00	262.
1.01	1.05	13	.01	0.00	.01	0.	1.01	13.05	157	.26	.25	.01	267.
1.01	1.10	14	.01	0.00	.01	0.	1.01	13.10	158	.26	.26	.00	282.
1.01	1.15	15	.01	0.00	.01	0.	1.01	13.15	159	.26	.26	.00	297.
1.01	1.20	16	.01	0.00	.01	0.	1.01	13.20	160	.26	.26	.00	306.
1.01	1.25	17	.01	0.00	.01	0.	1.01	13.25	161	.26	.26	.00	311.
1.01	1.30	18	.01	0.00	.01	0.	1.01	13.30	162	.26	.26	.00	314.
1.01	1.35	19	.01	0.00	.01	0.	1.01	13.35	163	.26	.26	.00	315.
1.01	1.40	20	.01	0.00	.01	0.	1.01	13.40	164	.26	.26	.00	316.
1.01	1.45	21	.01	0.00	.01	0.	1.01	13.45	165	.26	.26	.00	317.
1.01	1.50	22	.01	.00	.01	0.	1.01	13.50	166	.26	.26	.00	317.
1.01	1.55	23	.01	.00	.01	0.	1.01	13.55	167	.26	.26	.00	318.
1.01	2.00	24	.01	.00	.01	0.	1.01	14.00	168	.26	.26	.00	318.
1.01	2.05	25	.01	.00	.01	0.	1.01	14.05	169	.33	.32	.00	325.
1.01	2.10	26	.01	.00	.01	1.	1.01	14.10	170	.33	.32	.00	347.
1.01	2.15	27	.01	.00	.01	1.	1.01	14.15	171	.33	.32	.00	369.
1.01	2.20	28	.01	.00	.01	1.	1.01	14.20	172	.33	.32	.00	383.
1.01	2.25	29	.01	.00	.01	1.	1.01	14.25	173	.33	.32	.00	391.
1.01	2.30	30	.01	.00	.01	2.	1.01	14.30	174	.33	.32	.00	395.
1.01	2.35	31	.01	.00	.01	2.	1.01	14.35	175	.33	.32	.00	397.
1.01	2.40	32	.01	.00	.01	2.	1.01	14.40	176	.33	.32	.00	398.
1.01	2.45	33	.01	.00	.01	2.	1.01	14.45	177	.33	.32	.00	399.
1.01	2.50	34	.01	.00	.01	3.	1.01	14.50	178	.33	.32	.00	399.
1.01	2.55	35	.01	.00	.01	3.	1.01	14.55	179	.33	.32	.00	399.
1.01	3.00	36	.01	.00	.01	3.	1.01	15.00	180	.33	.32	.00	400.
1.01	3.05	37	.01	.00	.01	3.	1.01	15.05	181	.20	.20	.00	386.
1.01	3.10	38	.01	.00	.01	3.	1.01	15.10	182	.40	.39	.00	365.
1.01	3.15	39	.02	.00	.02	4.	1.01	15.15	183	.40	.39	.00	387.
1.01	3.20	40	.01	.00	.01	4.	1.01	15.20	184	.59	.59	.00	450.
1.01	3.25	41	.01	.00	.01	4.	1.01	15.25	185	.69	.69	.00	555.
1.01	3.30	42	.01	.00	.01	4.	1.01	15.30	186	1.68	1.67	.01	780.
1.01	3.35	43	.01	.00	.01	4.	1.01	15.35	187	2.77	2.76	.01	1315.
1.01	3.40	44	.01	.00	.01	5.	1.01	15.40	188	1.09	1.08	.00	1880.
1.01	3.45	45	.01	.00	.01	5.	1.01	15.45	189	.69	.69	.00	1886.
1.01	3.50	46	.01	.00	.01	5.	1.01	15.50	190	.59	.59	.00	1519.
1.01	3.55	47	.01	.00	.01	5.	1.01	15.55	191	.40	.39	.00	1140.
1.01	4.00	48	.01	.00	.01	5.	1.01	16.00	192	.40	.39	.00	878.
1.01	4.05	49	.01	.00	.01	5.	1.01	16.05	193	.30	.30	.00	689.
1.01	4.10	50	.01	.00	.01	6.	1.01	16.10	194	.30	.30	.00	558.
1.01	4.15	51	.01	.00	.01	6.	1.01	16.15	195	.30	.30	.00	474.
1.01	4.20	52	.01	.00	.01	6.	1.01	16.20	196	.30	.30	.00	427.
1.01	4.25	53	.01	.01	.01	6.	1.01	16.25	197	.30	.30	.00	402.
1.01	4.30	54	.01	.01	.01	6.	1.01	16.30	198	.30	.30	.00	388.
1.01	4.35	55	.01	.01	.01	6.	1.01	16.35	199	.30	.30	.00	380.
1.01	4.40	56	.01	.01	.01	6.	1.01	16.40	200	.30	.30	.00	377.
1.01	4.45	57	.01	.01	.01	7.	1.01	16.45	201	.30	.30	.00	376.
1.01	4.50	58	.01	.01	.01	7.	1.01	16.50	202	.30	.30	.00	375.
1.01	4.55	59	.01	.01	.01	7.	1.01	16.55	203	.30	.30	.00	375.
1.01	5.00	60	.01	.01	.01	7.	1.01	17.00	204	.30	.30	.00	375.

PLATE D-9

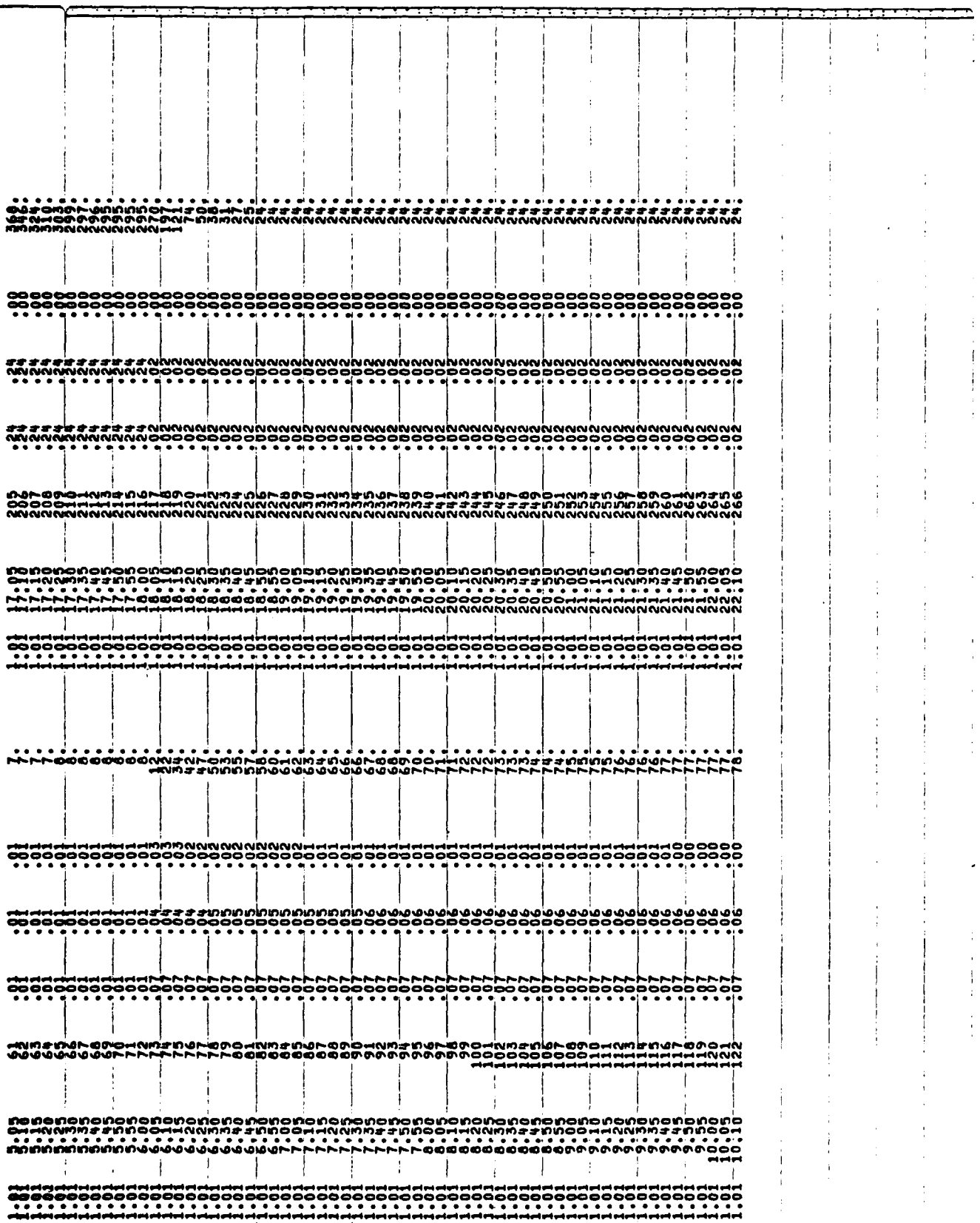


PLATE D-10

1:01	10.15	123	.07	.06	.00	78.	1:01	22.15	267	.02	.02	.00	24.
1:01	10.20	124	.07	.06	.00	78.	1:01	22.20	268	.02	.02	.00	24.
1:01	10.25	125	.07	.06	.00	78.	1:01	22.25	269	.02	.02	.00	24.
1:01	10.30	126	.07	.06	.00	78.	1:01	22.30	270	.02	.02	.00	24.
1:01	10.35	127	.07	.06	.00	78.	1:01	22.35	271	.02	.02	.00	24.
1:01	10.40	128	.07	.06	.00	78.	1:01	22.40	272	.02	.02	.00	24.
1:01	10.45	129	.07	.06	.00	78.	1:01	22.45	273	.02	.02	.00	24.
1:01	10.50	130	.07	.06	.00	79.	1:01	22.50	274	.02	.02	.00	24.
1:01	10.55	131	.07	.06	.00	79.	1:01	22.55	275	.02	.02	.00	24.
1:01	11.00	132	.07	.06	.00	79.	1:01	23.00	276	.02	.02	.00	24.
1:01	11.05	133	.07	.06	.00	79.	1:01	23.05	277	.02	.02	.00	24.
1:01	11.10	134	.07	.06	.00	79.	1:01	23.10	278	.02	.02	.00	24.
1:01	11.15	135	.07	.06	.00	79.	1:01	23.15	279	.02	.02	.00	24.
1:01	11.20	136	.07	.06	.00	79.	1:01	23.20	280	.02	.02	.00	24.
1:01	11.25	137	.07	.06	.00	79.	1:01	23.25	281	.02	.02	.00	24.
1:01	11.30	138	.07	.06	.00	79.	1:01	23.30	282	.02	.02	.00	24.
1:01	11.35	139	.07	.06	.00	79.	1:01	23.35	283	.02	.02	.00	24.
1:01	11.40	140	.07	.06	.00	80.	1:01	23.40	284	.02	.02	.00	24.
1:01	11.45	141	.07	.06	.00	80.	1:01	23.45	285	.02	.02	.00	24.
1:01	11.50	142	.07	.06	.00	80.	1:01	23.50	286	.02	.02	.00	24.
1:01	11.55	143	.07	.06	.00	80.	1:01	23.55	287	.02	.02	.00	24.
1:01	12.00	144	.07	.06	.00	80.	1:02	0.00	288	.02	.02	.00	24.
									SUM	33.15	31.57	1.58	39071.
										(842.)	(802.)	(40.)	(1106.37)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1886.	440.	136.	136.	39028.
CMS	53.	12.	4.	4.	1105.
INCHES		25.56	31.51	31.51	31.51
MM		649.21	800.47	800.47	800.47
AC-FT		218.	269.	269.	269.
THOUS CU M		269.	332.	332.	332.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	94.	22.	7.	7.	1951.
CMS	3.	1.	0.	0.	55.
INCHES		1.28	1.58	1.58	1.58
MM		32.46	40.02	40.02	40.02
AC-FT		11.	13.	13.	13.
THOUS CU M		13.	17.	17.	17.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 2

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	189.	44.	14.	14.	3903.
CMS	5.	1.	0.	0.	111.
INCHES		2.56	3.15	3.15	3.15
MM		64.92	80.05	80.05	80.05
AC-FT		22.	27.	27.	27.
THOUS CU M		27.	33.	33.	33.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 3

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	283.	66.	20.	20.	5854.
CMS	8.	2.	1.	1.	166.
INCHES		3.83	4.73	4.73	4.73
MM		97.38	120.07	120.07	120.07
AC-FT		33.	40.	40.	40.
THOUS CU M		40.	50.	50.	50.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 4

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	377.	88.	27.	27.	7806.
CMS	11.	2.	1.	1.	221.
INCHES		5.11	6.30	6.30	6.30
MM		129.84	160.09	160.09	160.09
AC-FT		44.	54.	54.	54.
THOUS CU M		54.	66.	66.	66.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 5

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	471.	110.	34.	34.	9757.
CMS	13.	3.	1.	1.	276.
INCHES		6.39	7.88	7.88	7.88
MM		162.30	200.12	200.12	200.12
AC-FT		54.	67.	67.	67.
THOUS CU M		67.	83.	83.	83.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 6

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	660.	154.	47.	47.	13660.
CMS	19.	4.	1.	1.	387.
INCHES		8.95	11.03	11.03	11.03
MM		227.22	280.16	280.16	280.16
AC-FT		76.	94.	94.	94.
THOUS CU M		94.	116.	116.	116.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 7 [1/2 PMF]

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	943.	220.	68.	68.	19514.
CMS	27.	6.	2.	2.	553.
INCHES		12.78	15.76	15.76	15.76
MM		324.60	400.24	400.24	400.24
AC-FT		109.	134.	134.	134.
THOUS CU M		134.	166.	166.	166.

HYDROGRAPH AT STA000001 FOR PLAN 1, RTIO 8 [PMF]

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1886.	440.	136.	136.	39028.

CMS	53.	12.	4.	4.	1105.	
INCHES		25.56	31.51	31.51	31.51	
MM		649.21	800.47	800.47	800.47	
AC-FT		218.	269.	269.	269.	
THOUS CU M		269.	332.	332.	332.	

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTED FLOWS THRU BECKER LAKE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
000002	1	0	0	2	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-107.	-1

STAGE	106.50	106.80	107.00	107.20	107.30	107.50	109.00	110.00	110.50	111.00
	111.50	112.00	112.50	113.00	113.50	114.00	114.50	115.00	116.00	
FLOW	0.00	.20	.60	.90	3.00	5.20	5.40	5.50	10.50	22.60
	47.00	88.00	141.00	204.00	284.00	379.00	491.00	616.00	906.00	
SURFACE AREA=	0.	0.	1.	2.	4.	5.	7.	10.		
CAPACITY=	0.	0.	4.	12.	27.	49.	81.	124.		
ELEVATION=	88.	90.	95.	100.	105.	110.	115.	120.		

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
106.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
111.6	2.8	1.5	295.

CREST LENGTH	100.	175.	180.	195.	245.	295.	307.
AT OR BELOW ELEVATION	111.6	112.1	112.1	112.3	112.7	112.8	115.0

~~STATION 000002, PLAN 1, RATIO 1~~

~~END-OF-PERIOD HYDROGRAPH ORDINATES~~

OUTFLOW

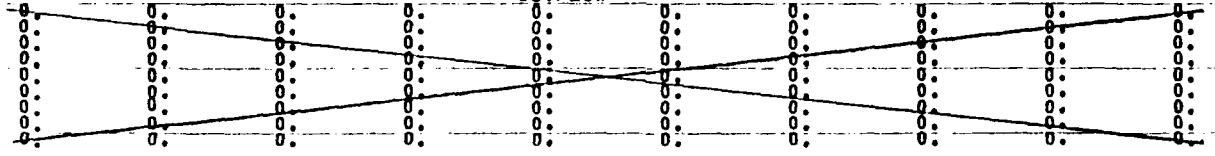


PLATE D-13

OVN

STATION 000002, PLAN 1, RATIO 7 ½ PMF

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.	1.	1.	1.	1.	1.	2.	3.	4.	4.
5.	5.	5.	5.	5.	5.	5.	5.	5.	5.
5.	5.	5.	5.	5.	5.	5.	5.	5.	5.
5.	5.	5.	5.	5.	5.	5.	5.	5.	5.
5.	5.	5.	5.	5.	5.	5.	5.	5.	5.
5.	5.	5.	5.	5.	5.	5.	5.	5.	5.
5.	5.	5.	5.	5.	5.	5.	5.	5.	5.
5.	5.	5.	5.	5.	6.	7.	8.	9.	11.
15.	18.	21.	26.	32.	38.	43.	49.	59.	79.
101.	119.	133.	142.	148.	152.	155.	156.	158.	162.
169.	177.	183.	189.	193.	195.	197.	198.	199.	199.
198.	193.	191.	199.	224.	280.	420.	673.	875.	857.
713.	567.	452.	367.	305.	262.	234.	217.	206.	198.
194.	191.	190.	189.	187.	184.	177.	169.	163.	158.
155.	152.	150.	149.	149.	148.	146.	135.	115.	94.
77.	64.	56.	52.	48.	46.	44.	42.	41.	39.
37.	36.	35.	33.	32.	31.	30.	29.	28.	27.
26.	25.	25.	24.	23.	23.	22.	22.	22.	21.
21.	21.	21.	20.	20.	20.	20.	19.	19.	19.
19.	19.	18.	18.	18.	18.	18.	17.	17.	17.
17.	17.	17.	17.	16.	16.	16.	16.	16.	16.
16.	16.	15.	15.	15.	15.	15.	15.		

STORAGE

33.	33.	33.	33.	33.	33.	33.	33.	33.	33.
33.	33.	33.	33.	33.	33.	33.	33.	33.	33.
33.	33.	33.	33.	33.	33.	33.	33.	33.	33.
33.	33.	33.	33.	33.	33.	33.	33.	33.	33.
33.	33.	33.	33.	33.	33.	33.	33.	33.	33.
33.	33.	33.	33.	33.	33.	33.	33.	33.	33.
33.	33.	33.	33.	33.	33.	33.	33.	33.	33.
33.	33.	33.	33.	33.	33.	33.	33.	33.	33.
33.	33.	34.	34.	34.	34.	34.	34.	34.	34.
35.	35.	35.	35.	35.	36.	36.	36.	36.	36.
37.	37.	37.	37.	37.	38.	38.	38.	38.	39.
39.	39.	39.	39.	40.	40.	40.	40.	40.	41.
41.	41.	41.	42.	42.	42.	42.	42.	43.	43.
43.	43.	44.	44.	44.	44.	45.	45.	45.	45.
45.	46.	46.	46.	46.	47.	47.	47.	47.	48.
48.	48.	48.	49.	49.	49.	50.	50.	51.	52.
53.	53.	54.	55.	56.	56.	57.	58.	58.	59.
59.	60.	60.	60.	60.	60.	60.	60.	60.	60.
60.	60.	60.	60.	61.	61.	61.	61.	61.	61.
61.	61.	61.	61.	61.	61.	63.	64.	66.	65.
65.	64.	63.	62.	62.	61.	61.	61.	61.	61.
61.	61.	61.	60.	60.	60.	60.	60.	60.	60.
60.	60.	60.	60.	60.	60.	60.	60.	59.	59.
59.	58.	58.	58.	58.	57.	57.	57.	57.	56.
56.	56.	56.	56.	56.	56.	55.	55.	55.	55.

55.	55.	55.	55.	55.	55.	54.	54.	54.	54.
54.	54.	54.	54.	54.	54.	54.	54.	54.	54.
54.	54.	54.	54.	53.	53.	53.	53.	53.	53.
53.	53.	53.	53.	53.	53.	53.	53.	53.	53.
53.	53.	53.	53.	53.	53.	53.	53.	53.	

STAGE

106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5
106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5
106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5
106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5
106.5	106.5	106.5	106.5	106.5	106.5	106.6	106.6	106.6	106.6
106.6	106.6	106.6	106.6	106.6	106.6	106.6	106.6	106.6	106.6
106.6	106.6	106.6	106.6	106.6	106.7	106.7	106.7	106.7	106.7
106.7	106.7	106.7	106.7	106.7	106.8	106.8	106.8	106.9	106.9
107.0	107.0	107.1	107.1	107.2	107.2	107.3	107.3	107.3	107.4
107.4	107.5	107.5	107.6	107.6	107.7	107.7	107.8	107.8	107.9
107.9	107.9	108.0	108.0	108.1	108.1	108.2	108.2	108.3	108.3
108.4	108.4	108.5	108.5	108.6	108.6	108.7	108.7	108.8	108.8
108.8	108.9	108.9	109.0	109.0	109.1	109.1	109.2	109.2	109.3
109.3	109.4	109.4	109.4	109.5	109.5	109.6	109.6	109.7	109.7
109.8	109.8	109.9	109.9	110.0	110.0	110.1	110.3	110.4	110.5
110.7	110.8	110.9	111.1	111.2	111.3	111.4	111.5	111.6	111.7
111.8	111.8	111.9	111.9	111.9	111.9	111.9	111.9	111.9	112.0
112.0	112.0	112.0	112.0	112.0	112.0	112.0	112.0	112.0	112.0
112.0	112.0	112.0	112.0	112.1	112.2	112.4	112.6	112.8	112.8
112.7	112.5	112.4	112.3	112.2	112.1	112.1	112.1	112.0	112.0
112.0	112.0	112.0	112.0	112.0	112.0	112.0	112.0	112.0	111.9
111.9	111.9	111.9	111.9	111.9	111.9	111.9	111.9	111.8	111.8
111.7	111.7	111.6	111.6	111.5	111.5	111.4	111.4	111.4	111.3
111.3	111.3	111.2	111.2	111.2	111.2	111.2	111.1	111.1	111.1
111.1	111.1	111.0	111.0	111.0	111.0	111.0	111.0	111.0	111.0
110.9	110.9	110.9	110.9	110.9	110.9	110.9	110.9	110.9	110.9
110.8	110.8	110.8	110.8	110.8	110.8	110.8	110.8	110.8	110.8
110.8	110.8	110.8	110.8	110.7	110.7	110.7	110.7	110.7	110.7
110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7		

PEAK OUTFLOW IS 875. AT TIME 15.75 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	875.	206.	58.	58.	16606.
CMS	25.	6.	2.	2.	470.
INCHES		11.96	13.41	13.41	13.41
MM		303.73	340.59	340.59	340.59
AC-FT		102.	114.	114.	114.
THOUS CU M		126.	141.	141.	141.

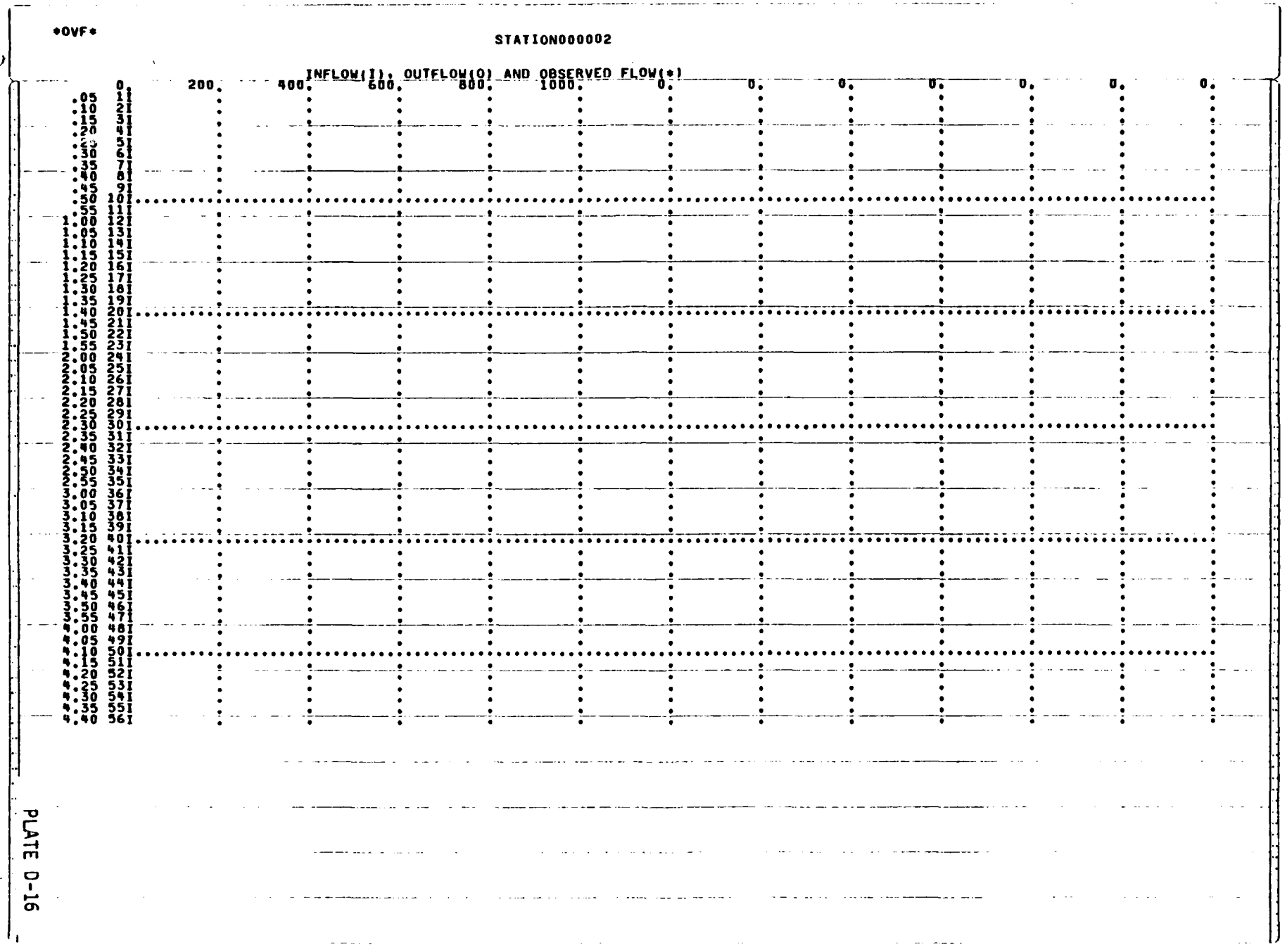

OVF
STATION000002
INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)
0 200 400 600 800 1000 0 0 0 0 0 0 0
.05 1I
.10 2I
.15 3I
.20 4I
.25 5I
.30 6I
.35 7I
.40 8I
.45 9I
.50 10I
.55 11I
1.00 12I
1.05 13I
1.10 14I
1.15 15I
1.20 16I
1.25 17I
1.30 18I
1.35 19I
1.40 20I
1.45 21I
1.50 22I
1.55 23I
2.00 24I
2.05 25I
2.10 26I
2.15 27I
2.20 28I
2.25 29I
2.30 30I
2.35 31I
2.40 32I
2.45 33I
2.50 34I
2.55 35I
3.00 36I
3.05 37I
3.10 38I
3.15 39I
3.20 40I
3.25 41I
3.30 42I
3.35 43I
3.40 44I
3.45 45I
3.50 46I
3.55 47I
4.00 48I
4.05 49I
4.10 50I
4.15 51I
4.20 52I
4.25 53I
4.30 54I
4.35 55I
4.40 56I

PLATE D-16

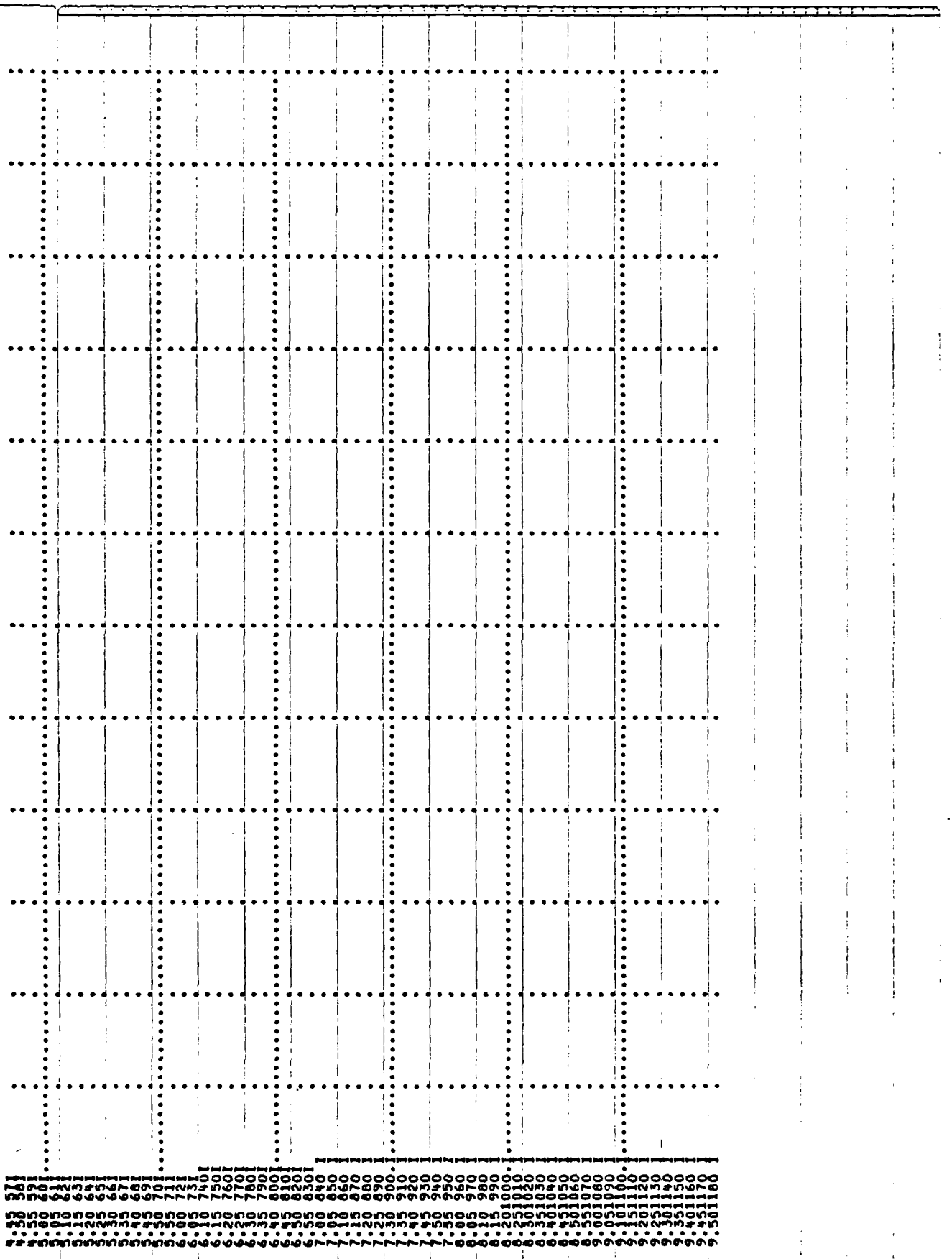


PLATE D-17

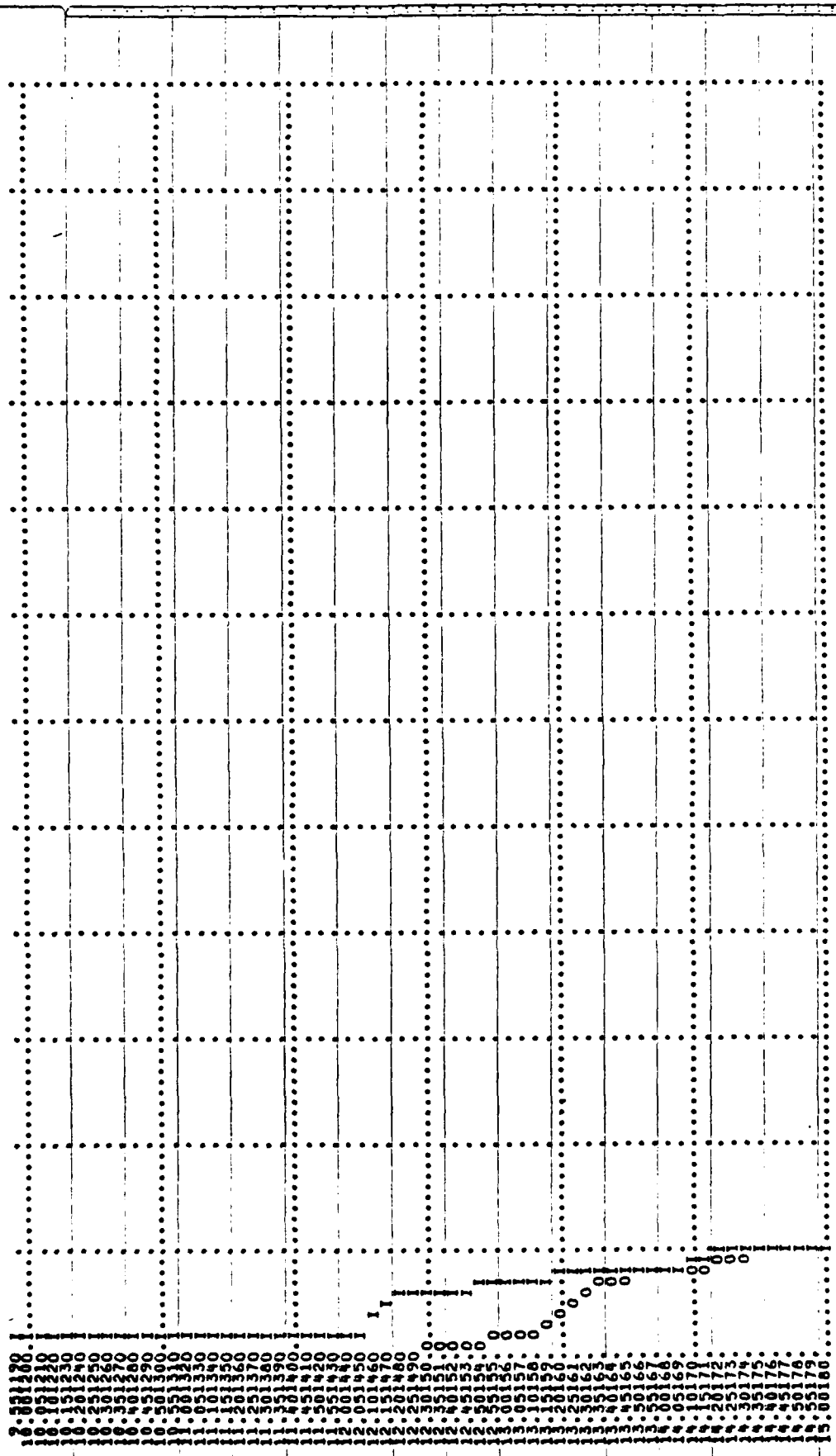


PLATE D-18

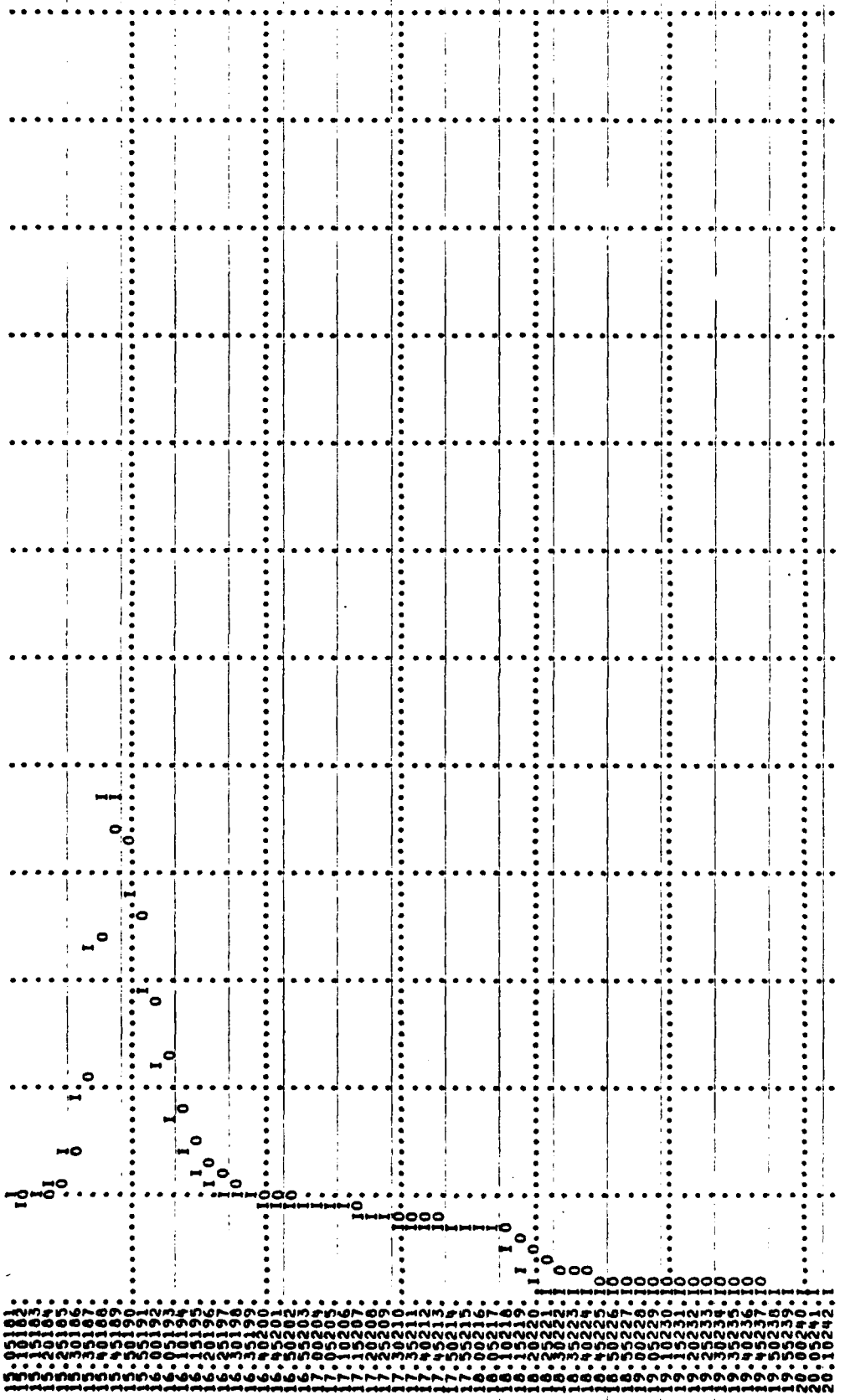


PLATE D-19

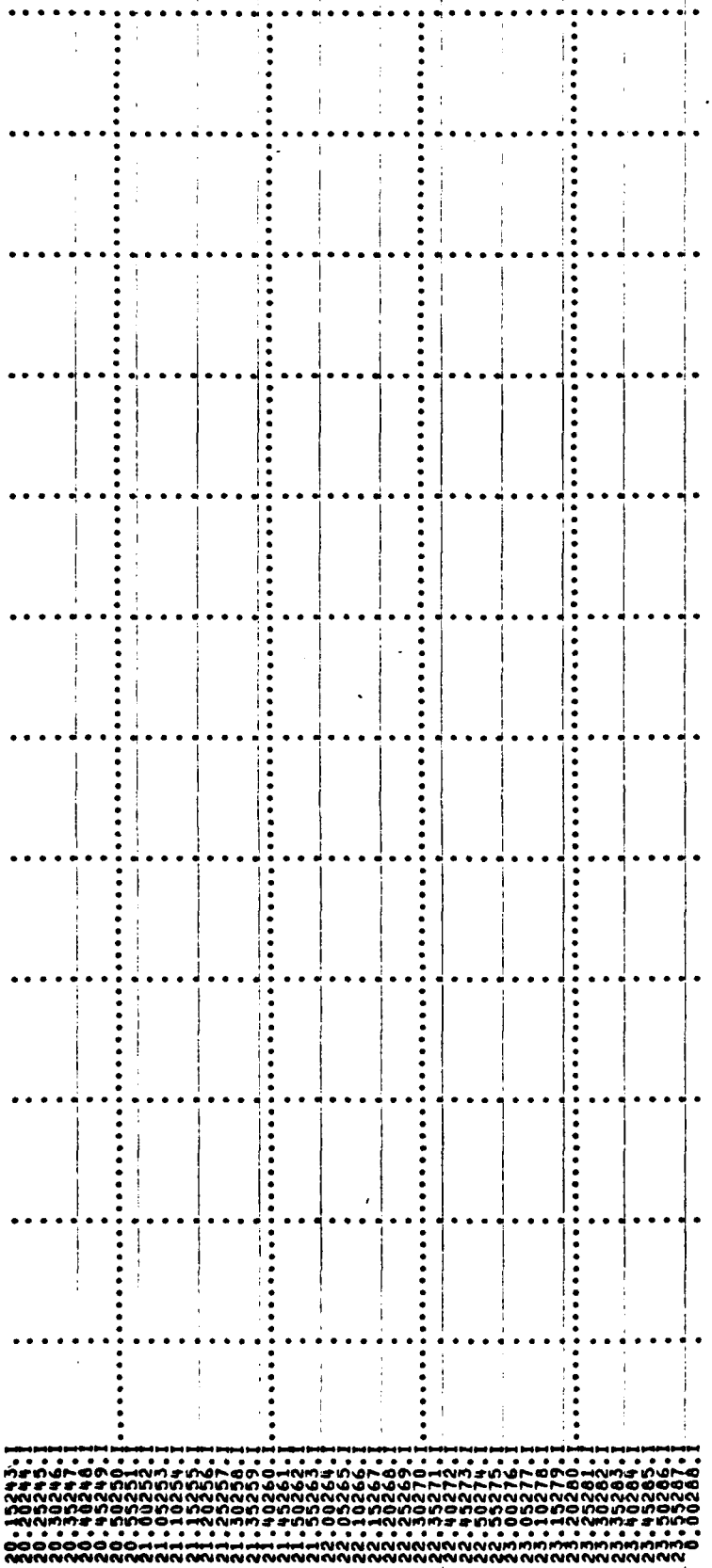


PLATE D-20

OVN

STATION 000002, PLAN 1, RATIO 8 PMF

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	1.	1.	1.	2.	3.
4.	5.	5.	5.	5.	5.	5.	5.	5.	5.
5.	5.	5.	5.	5.	5.	5.	5.	5.	5.
5.	5.	5.	5.	5.	5.	5.	5.	5.	6.
7.	8.	8.	9.	10.	12.	13.	15.	17.	19.
21.	22.	25.	28.	31.	34.	36.	38.	41.	43.
45.	47.	49.	52.	55.	57.	61.	64.	68.	70.
72.	74.	75.	76.	79.	91.	115.	150.	184.	213.
232.	244.	251.	256.	258.	260.	262.	268.	279.	291.
300.	307.	311.	314.	315.	316.	317.	317.	320.	329.
345.	363.	377.	386.	391.	395.	397.	398.	399.	399.
395.	384.	379.	402.	464.	599.	936.	1514.	1859.	1711.
1363.	1056.	834.	677.	564.	489.	442.	413.	396.	386.
380.	378.	376.	376.	373.	364.	347.	330.	317.	308.
303.	299.	297.	296.	295.	295.	289.	260.	210.	161.
123.	97.	79.	67.	59.	55.	52.	49.	47.	46.
45.	43.	42.	41.	40.	40.	39.	38.	37.	36.
36.	35.	34.	34.	33.	33.	32.	32.	31.	31.
30.	30.	30.	29.	29.	29.	28.	28.	28.	28.
27.	27.	27.	27.	27.	27.	26.	26.	26.	26.
26.	26.	26.	25.	25.	25.	25.	25.	25.	25.
25.	25.	25.	25.	25.	25.	24.	24.		

STORAGE

33.	33.	33.	33.	33.	33.	33.	33.	33.	33.
33.	33.	33.	33.	33.	33.	33.	33.	33.	33.
33.	33.	33.	33.	33.	33.	33.	33.	33.	33.
33.	33.	33.	33.	33.	33.	33.	33.	33.	33.
33.	33.	33.	33.	33.	33.	33.	33.	33.	33.
33.	33.	33.	33.	33.	33.	34.	34.	34.	34.
34.	34.	34.	34.	34.	34.	34.	34.	34.	34.
34.	34.	34.	34.	35.	35.	35.	36.	36.	36.
37.	37.	37.	38.	38.	38.	39.	39.	40.	40.
41.	41.	41.	42.	42.	43.	43.	44.	44.	44.
45.	45.	46.	46.	47.	47.	48.	48.	49.	49.
50.	50.	51.	51.	52.	52.	52.	53.	53.	54.
54.	54.	55.	55.	56.	56.	56.	56.	57.	57.
57.	57.	58.	58.	58.	58.	58.	58.	58.	59.
59.	59.	59.	59.	59.	59.	59.	60.	60.	61.
61.	61.	61.	61.	61.	61.	61.	61.	61.	62.
62.	62.	62.	62.	62.	62.	62.	62.	62.	62.
62.	62.	62.	62.	62.	62.	62.	62.	62.	62.
62.	62.	62.	63.	63.	64.	66.	68.	70.	69.
68.	66.	65.	64.	64.	63.	63.	63.	62.	62.
62.	62.	62.	62.	62.	62.	62.	62.	62.	62.
62.	62.	62.	62.	62.	62.	62.	61.	61.	60.
60.	59.	59.	58.	58.	58.	58.	58.	57.	57.
57.	57.	57.	57.	57.	57.	56.	56.	56.	56.

PLATE D-21

56.	56.	56.	56.	56.	56.	56.	56.	56.	56.
55.	55.	55.	55.	55.	55.	55.	55.	55.	55.
55.	55.	55.	55.	55.	55.	55.	55.	55.	55.
55.	55.	55.	55.	55.	55.	55.	55.	55.	55.
55.	55.	55.	55.	55.	55.	55.	55.	55.	55.

STAGE

106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5
106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5
106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5
106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.5	106.6
106.6	106.6	106.6	106.6	106.6	106.6	106.6	106.6	106.6	106.6
106.6	106.7	106.7	106.7	106.7	106.7	106.7	106.7	106.7	106.7
106.7	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.8	106.9
106.9	106.9	106.9	106.9	107.0	107.0	107.1	107.2	107.3	107.3
107.4	107.5	107.6	107.7	107.8	107.8	107.9	108.0	108.1	108.2
108.3	108.4	108.5	108.6	108.7	108.7	108.8	108.9	109.0	109.1
109.2	109.3	109.4	109.5	109.6	109.7	109.8	109.8	109.9	110.0
110.1	110.2	110.3	110.4	110.5	110.5	110.6	110.7	110.8	110.8
110.9	111.0	111.0	111.1	111.2	111.2	111.3	111.3	111.4	111.4
111.5	111.5	111.5	111.6	111.6	111.6	111.6	111.7	111.7	111.7
111.7	111.7	111.7	111.7	111.7	111.8	111.8	111.9	112.0	112.1
112.1	112.1	112.1	112.1	112.1	112.1	112.1	112.1	112.2	112.2
112.2	112.2	112.2	112.2	112.2	112.2	112.2	112.2	112.2	112.2
112.3	112.3	112.3	112.3	112.3	112.3	112.3	112.3	112.3	112.3
112.3	112.3	112.3	112.3	112.4	112.6	112.9	113.3	113.5	113.4
113.2	113.0	112.8	112.6	112.5	112.4	112.4	112.4	112.3	112.3
112.3	112.3	112.3	112.3	112.3	112.3	112.3	112.2	112.2	112.2
112.2	112.2	112.2	112.2	112.2	112.2	112.2	112.1	112.1	112.0
111.9	111.8	111.7	111.7	111.6	111.6	111.6	111.5	111.5	111.5
111.5	111.4	111.4	111.4	111.4	111.3	111.3	111.3	111.3	111.3
111.3	111.3	111.2	111.2	111.2	111.2	111.2	111.2	111.2	111.2
111.2	111.2	111.1	111.1	111.1	111.1	111.1	111.1	111.1	111.1
111.1	111.1	111.1	111.1	111.1	111.1	111.1	111.1	111.1	111.1
111.1	111.1	111.1	111.1	111.1	111.1	111.1	111.1	111.0	111.0
111.0	111.0	111.0	111.0	111.0	111.0	111.0	111.0		

PEAK OUTFLOW IS 1859. AT TIME 15.75 HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	1859.	438.	124.	124.	35822.
CMS	53.	12.	4.	4.	1014.
INCHES		25.44	28.93	28.93	28.93
MM		646.18	734.73	734.73	734.73
AC-FT		217.	247.	247.	247.
THOUS CU M		268.	304.	304.	304.

PLATE D-22

OVF

STATION000002

INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)

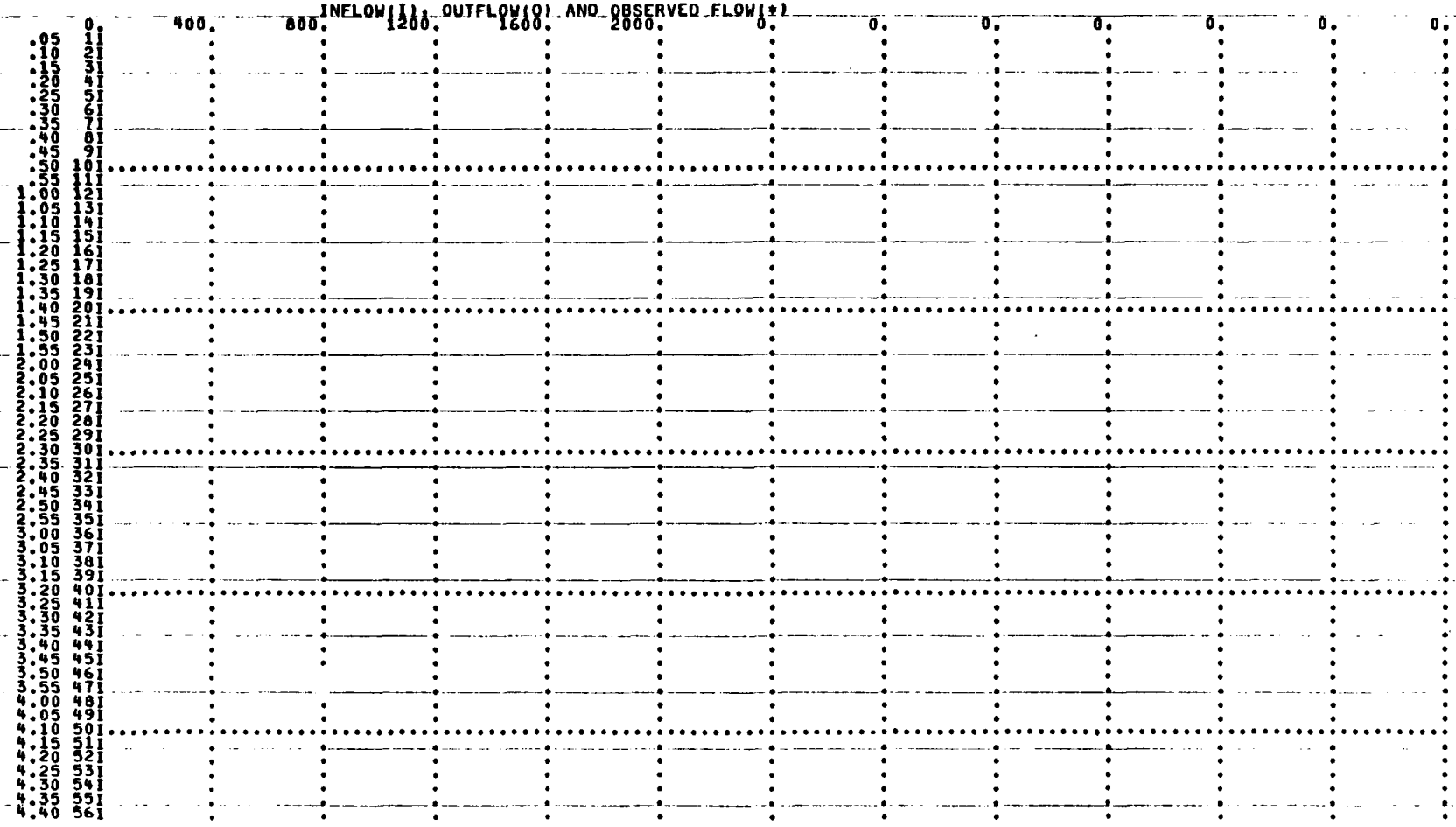


PLATE D-23

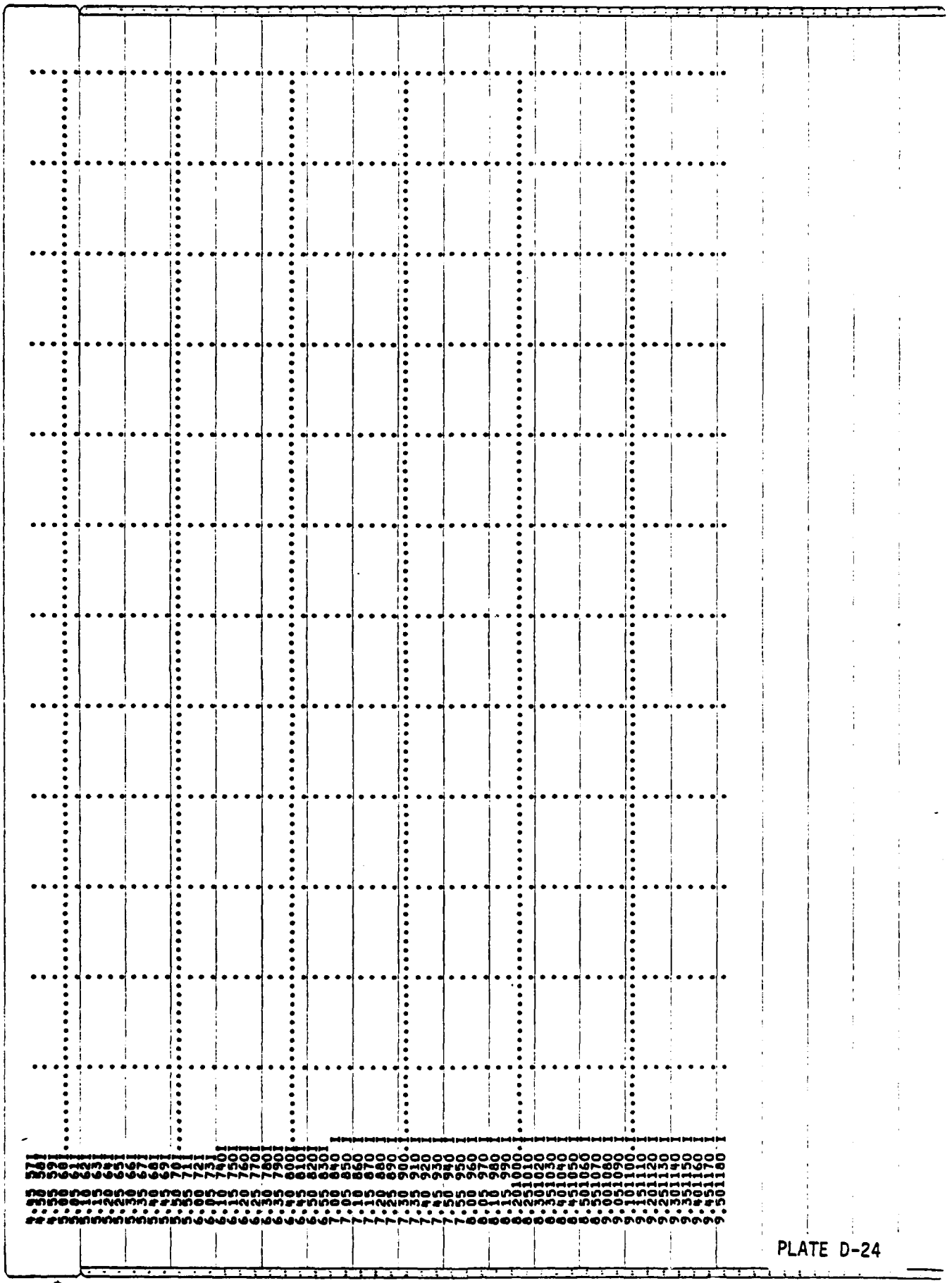


PLATE D-24

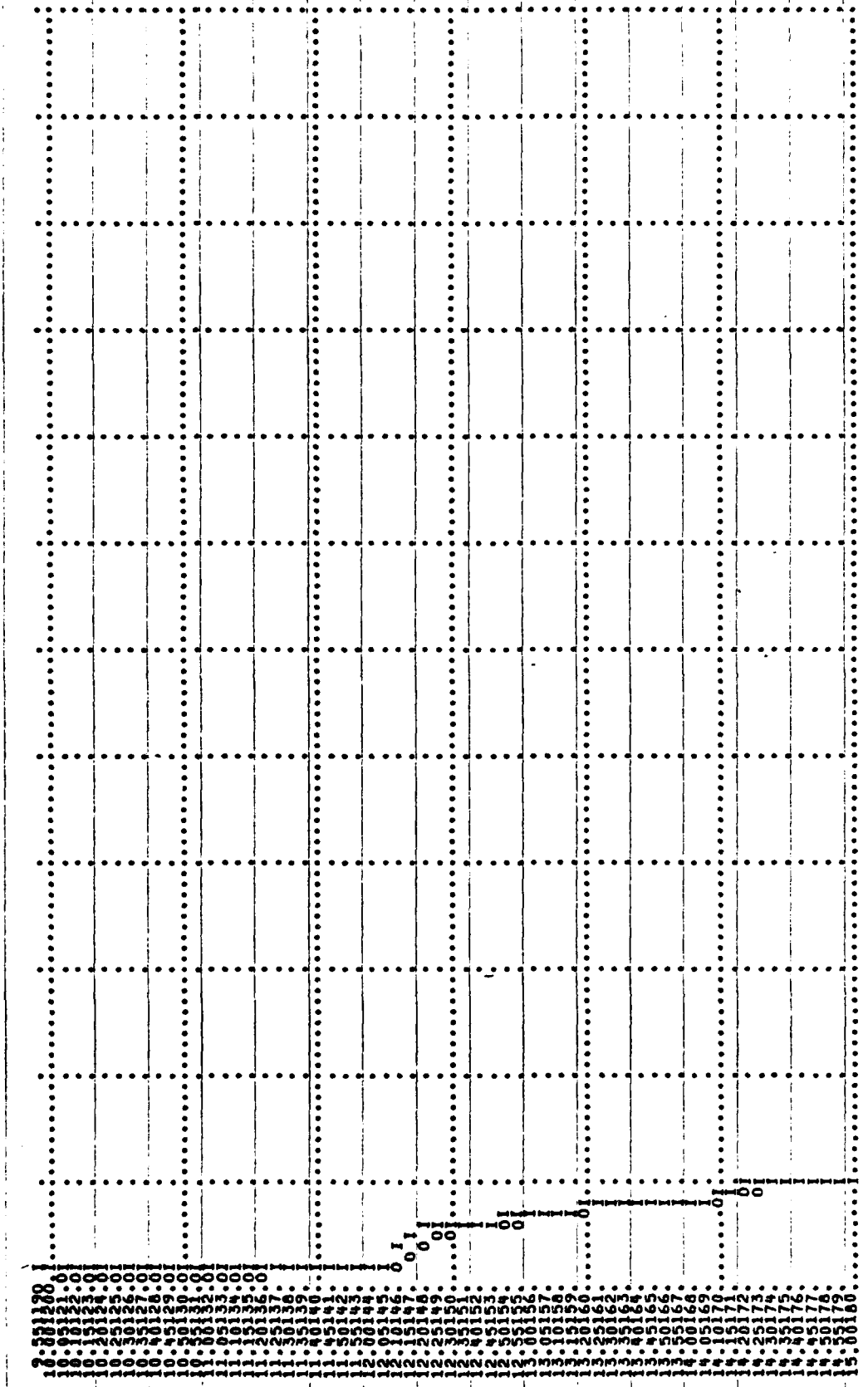


PLATE D-25

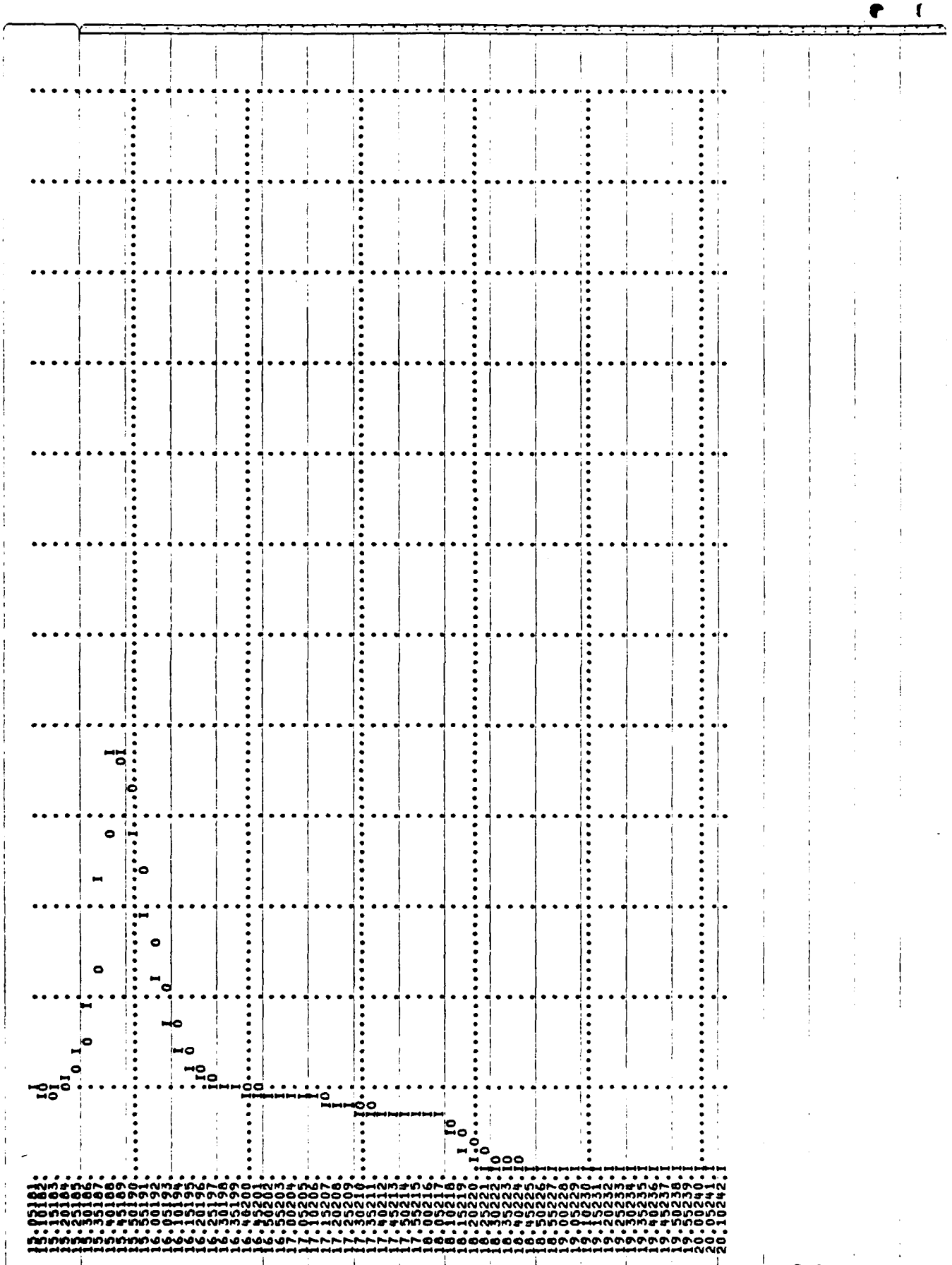


PLATE D-26

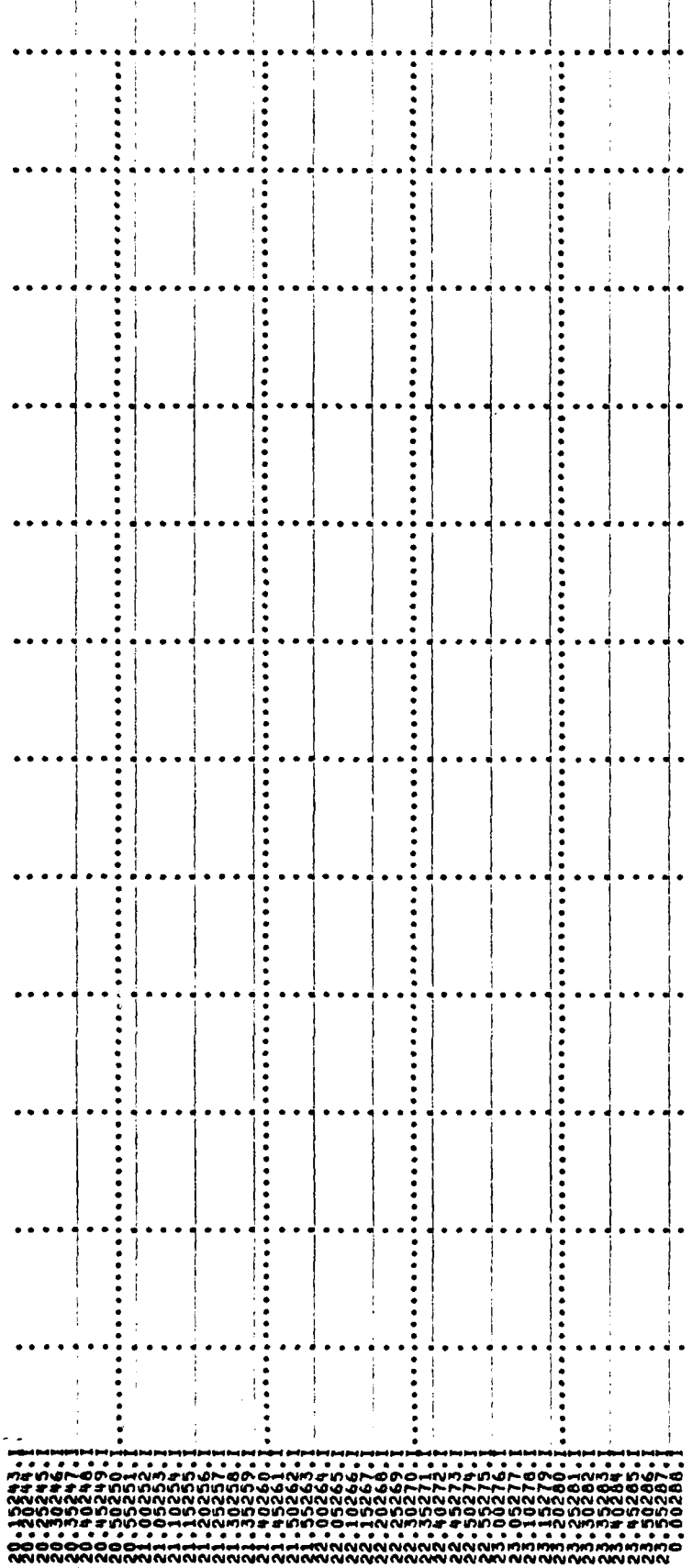


PLATE D-27

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS							
				RATIO 1 .05	RATIO 2 .10	RATIO 3 .15	RATIO 4 .20	RATIO 5 .25	RATIO 6 .35	RATIO 7 .50	RATIO 8 1.00
HYDROGRAPH AT	000001	.16 (.41)	1	94, (2.67)	189, (5.34)	283, (8.01)	377, (10.68)	471, (13.35)	660, (18.69)	943, (26.70)	1886, (53.39)
ROUTED TO	000002	.16 (.41)	1	5, (.15)	19, (.55)	64, (1.81)	251, (7.10)	406, (11.50)	592, (16.75)	875, (24.79)	1659, (52.64)

PLATE D-28

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	106.50	106.50	111.60
STORAGE	33.	33.	58.
OUTFLOW	0.	0.	55.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.05	108.89	0.00	43.	5.	0.00	18.25	0.00
.10	110.86	0.00	54.	19.	0.00	10.17	0.00
.15	111.65	.05	58.	64.	1.25	16.33	0.00
.20	112.12	.52	61.	251.	2.58	15.92	0.00
.25	112.34	.74	63.	402.	3.00	15.83	0.00
.35	112.55	.95	64.	592.	4.17	15.83	0.00
.50	112.81	1.21	66.	875.	5.42	15.75	0.00
1.00	113.46	1.86	70.	1859.	7.50	15.75	0.00

PLATE D-29


DATE
ILME